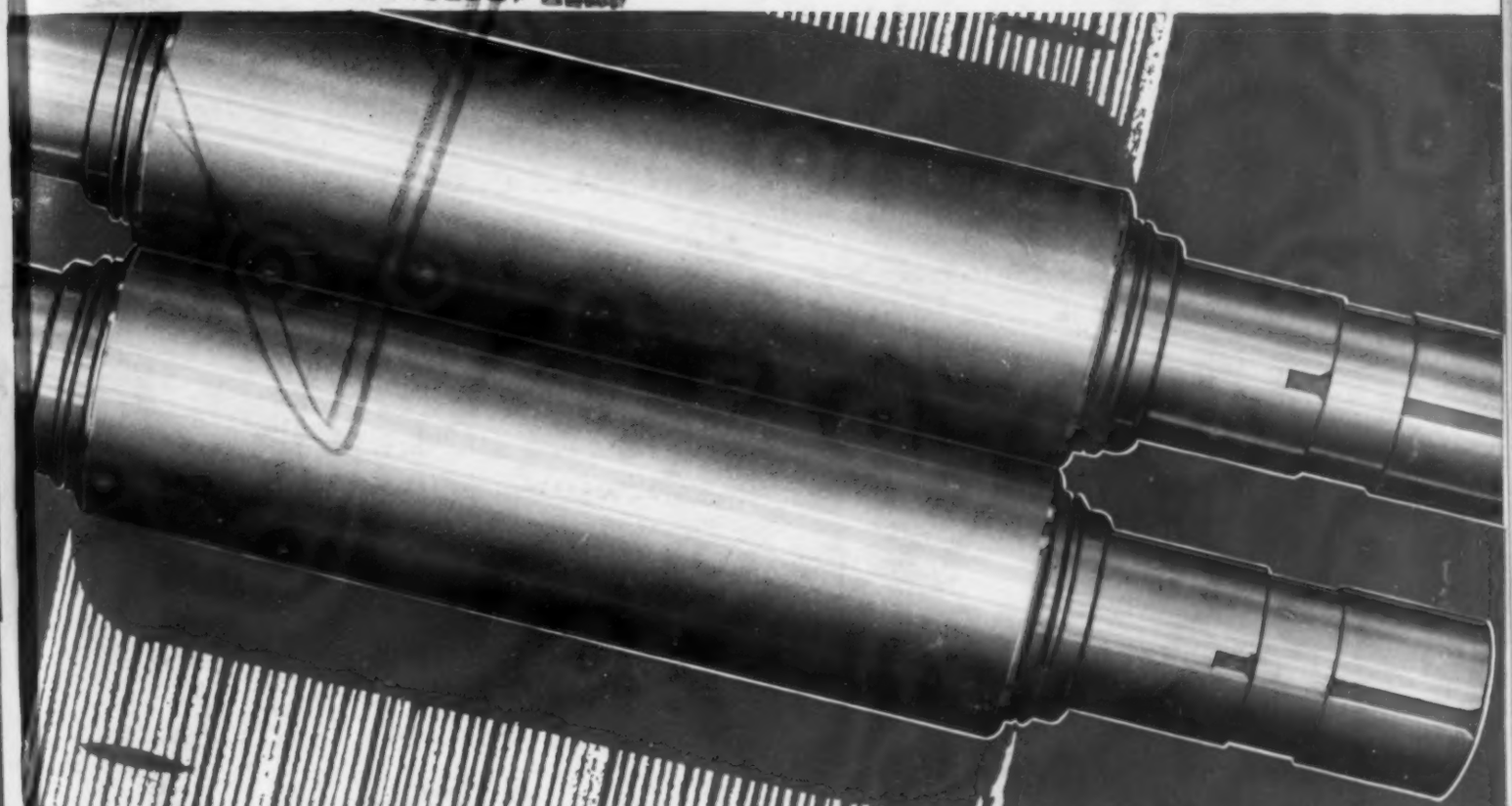
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

FEBRUARY, 1954 TECHNOLOGY [illegible]

TABLE OF CONTENTS, Page 51



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SHAPING METAL FOR ALL INDUSTRY

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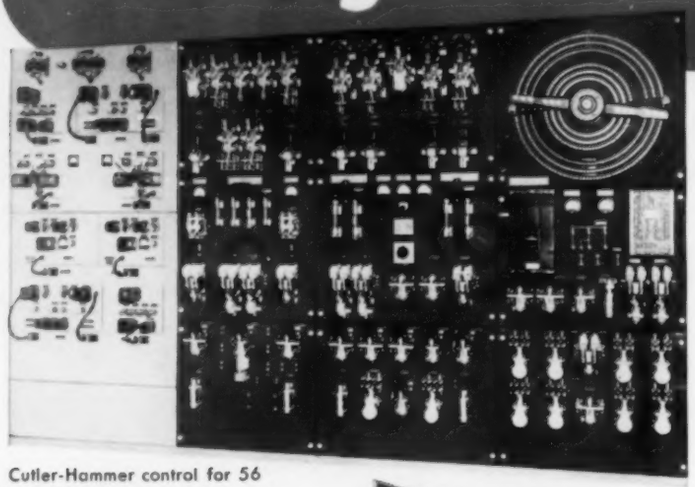
NIOLOY ROLLS • FLINTUFF ROLLS • OHIO DOUBLE-POUR ROLLS

THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO • Plants at Lima and Springfield, Ohio

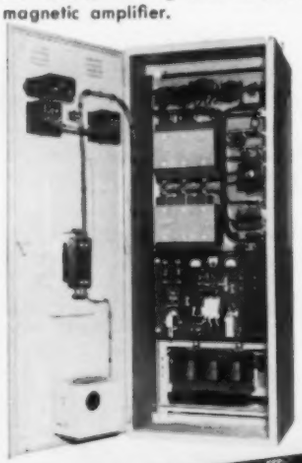
[illegible] LIBRARY FEB [illegible] DETROIT

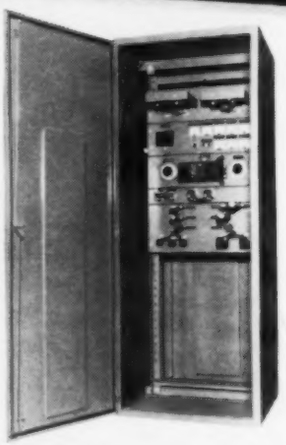
Nothing succeeds like success!



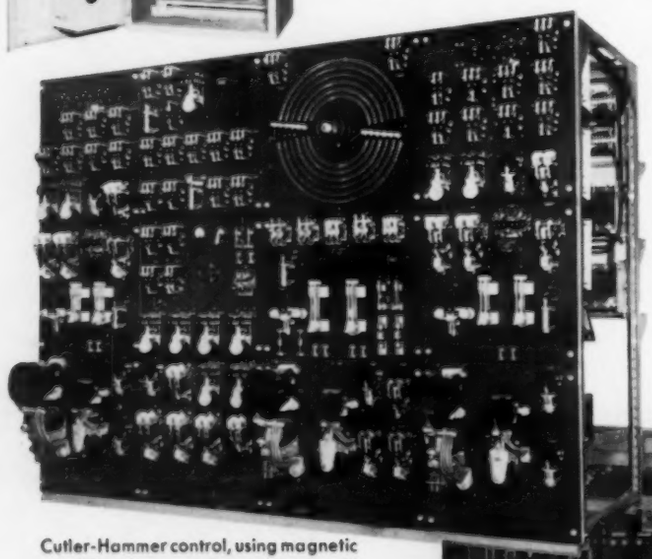
Cutler-Hammer control for 56 inch side trimming and shear line using magnetic amplifier.

Cutler-Hammer high frequency control for electric welding tube mill, using magnetic amplifier.

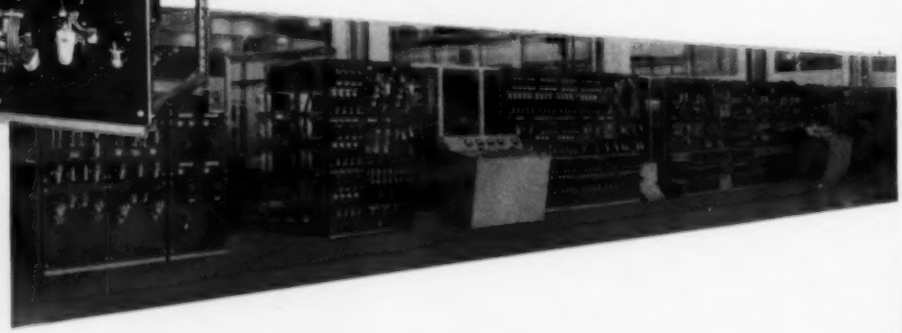




Cutler-Hammer magnetic amplifier speed regulator for a large tube mill.



Cutler-Hammer control, using magnetic amplifier, for reversing cold strip mill with tension and voltage regulation.



Cutler-Hammer D-C Controllers using magnetic amplifier for pipe mill in a southwestern steel mill.

Cutler-Hammer's experience in applying the Magnetic Amplifier to steel mill control assures correct solution of your problems.

Cutler-Hammer has been so successful in the past in applying the magnetic amplifier to steel mill control schemes, it is very natural that companies looking for best results should come to Cutler-Hammer.

This further adds to Cutler-Hammer's backlog of experience, and gives more positive assurance that the control scheme will properly apply and utilize all the inherent advantages of this dependable control component that has no moving parts, is capable of split-second response and many amazing features. . . . Nothing succeeds like success! CUTLER-HAMMER, Inc., 1269 W. St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER·HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 31, No. 2.

TIN SHEARING LINE . . . Receives coils (up to 36,000 pounds) from Temper Mill. Material is side trimmed, sheared to specified lengths and classified into primes and seconds . . . all automatically. This Aetna-built line in the Fairless Works of U. S. Steel has a rated speed of 1250 f.p.m. for regular tin plate gauges in sheet sizes up to 38" x 43".

Tin Shearing Line built by Aetna-Standard for Fairless Works, U. S. Steel.

Flat-Rolled Equipment

SHEARING AND CLASSIFYING · SCRUBBING AND DRYING · RECOILING · SLITTING AND SIDE TRIMMING · ROLLER LEVELERS · PAY-OFF AND TENSION REELS · SIDE TRIM AND RECOIL · SIDE TRIM AND SHEAR · TIN PLATE, SIDE TRIM AND SHEAR · CLASSIFYING

SIDE TRIMMING AND RECOILING LINE . . . This 40" line prepares coils for the Electrolytic Tinning Line of Fairless Works, U. S. Steel. The strip (in coil form) is side trimmed at speeds up to 4000 f.p.m. The line operates under tension with ends of coils joined by seam welding. Close tolerance and high speeds are essential to the successful operation of the line.

40" Side Trimming and Recoiling Line in Fairless Works of U. S. Steel.

THE AETNA-STANDARD ENGINEERING COMPANY · PITTSBURGH, PA.

Aetna-Standard

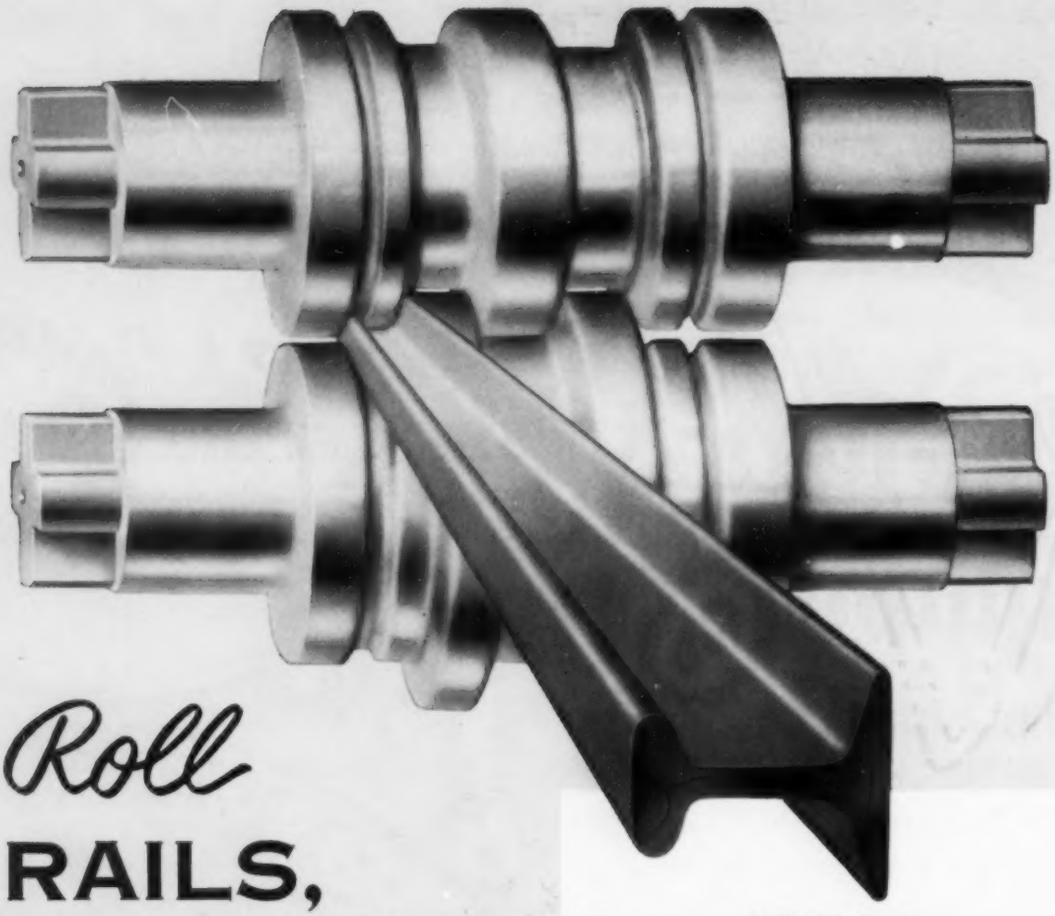
PLANTS IN WARREN, OHIO · ELLWOOD CITY, PENNSYLVANIA

GOOD EQUIPMENT BRINGS DOWN PRODUCTION COSTS

SUBSIDIARY and ASSOCIATED COMPANIES

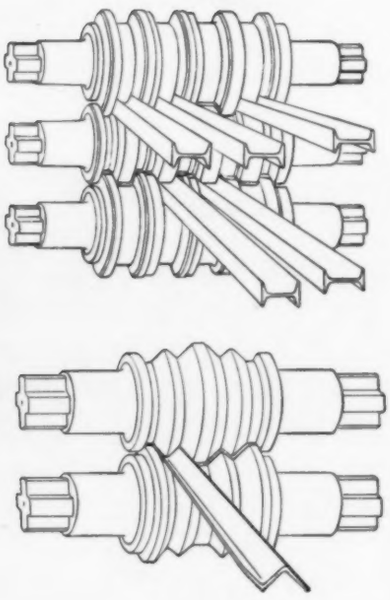
Head Wrightson Machine Company, Ltd., Middlesbrough, England — Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.
Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.
M. Castellvi, Inc., New York, N. Y. — Mexico, Central and South America.
Societe de Constructions de Montbard, Paris, France — France, Belgium, Holland, Luxembourg, Switzerland.
Demag Aktiengesellschaft, Duisburg, Germany — Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.
Compagnia Italiana Forme Acciaio, Milano, Italy — Italy.
Aetna-Japan Company, Ltd., Tokyo, Japan — Japan.
Hale & Kullgren, Inc., Akron, Ohio — Representative for the Rubber Industry.
Standard Engineering Company, Ellwood City, Pa.
Trans-World Traders, Pittsburgh, Pa.

Designers and Builders to the Ferrous, Non-Ferrous, Leather, Rubber, and Plastic Industries



Roll
RAILS, BEAMS and BARS with

National Rolls



for Accurate Forming at Minimum Cost

THE NATIONAL ROLL & FOUNDRY CO.
Avonmore, Pennsylvania

SPECIALISTS IN IRON, ALLOY IRON AND STEEL ROLLS AND CASTINGS
STEEL ARMOR CASTINGS

NATIONAL ROLLS

Bucket crane of the Level-Luffing type operates speedily under EC&M Contra Torque Hoist Control.

CONTRA TORQUE

Bucket cranes in this fertilizer plant operate at high output with EC&M Contra Torque Hoist Control.

How EC&M Frequency Relay Control improves A-C Bucket Cranes

FAST GETAWAY—Quickly responsive to the frequency of the induced-rotor voltage, EC&M Frequency Relays match torque requirements to the load . . . get the motor up to speed quickly for lowering the bucket —to move the trolley in or out . . . cut down the time between trips.

WIDE SPEED SELECTION—These Relays permit starting-down on any master switch point—no waiting until last point is reached. And a better speed choice gives greater flexibility in clean-up operations, and speeds up output.

SMOOTH STOPPING—When checking motor lowering speed, weak torques are provided for light loads or the empty bucket; stronger torques for heavier loads. Trolley motor is stopped and reversed smoothly under Frequency Relay automatic operation.

SPEED-LIMITING *Safety* on all Speeds. These relays (one set for hoisting and lowering) automatically shift motor connections to safeguard lowering operation with greater skill than human hands could do it.

It Pays To Specify E&M *Control*

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET • CLEVELAND 4, OHIO

ELLIOTT Motors

◀ The main mill drive reversing motor—an Elliott 800-hp, 175/350-rpm, 600-v. At right and left, two Elliott 250-hp, 400/1200-rpm, 250-v reversing mill type reel motors.

The main motor-generator set—one 750-kw, 600-v, d-c mill generator, two 200-kw, 250-v, d-c reel generators, one 1500-hp, 4100-v synchronous motor, and one 30-kw, d-c exciter. All Elliott. ▼

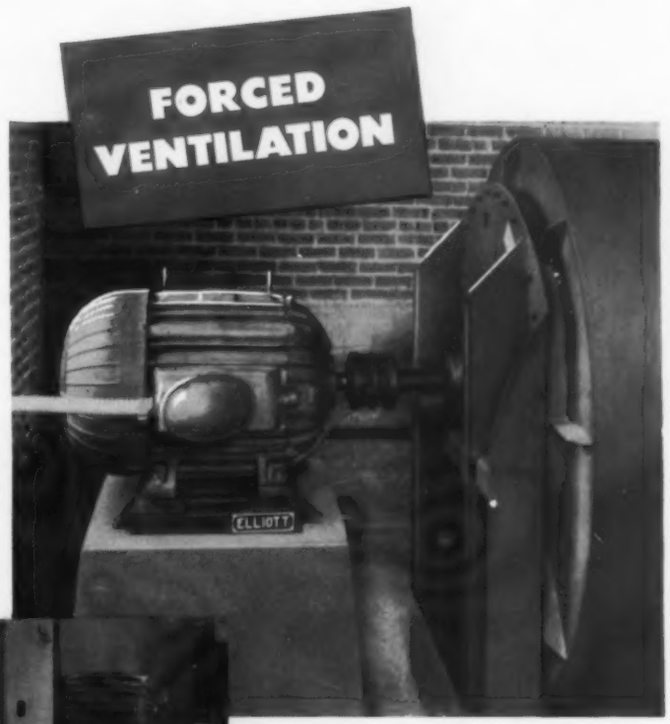
Elliott FABRI-STEEL MOTORS AND GENERATORS Q3-5

and Generators

power the new cold mill and slitter line for the Athenia Division, National Standard Co.

• The new Bliss 10 in. and 24 in. by 20 in. Four-High Reversing Cold Reduction Mill, with the Bliss 16 in. by 18 in. Slitter, adds new high capacity as well as quality product for the National Standard Company's Athenia Steel Division.

All electric motor drives, generators, and control for both the mill and the slitter line were furnished by Elliott Company. Generators, motors, and control have been carefully coordinated to give the close speed regulation necessary for the production of high quality strip.



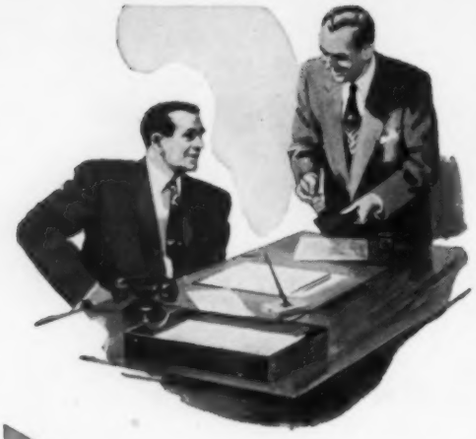
▲ The Elliott C-W "Sealedpower" 40-hp totally-enclosed fan-cooled motor that drives the fan supplying ventilation for the mill and reel motors.

◀ The drive for the Bliss Slitter is a Crocker-Wheeler 75-hp drip-proof induction motor. In the right background, an Elliott C-W 15-hp threader motor.

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

CROCKER-WHEELER DIVISION • RIDGWAY DIVISION



SEE RUST-OLEUM APPLIED DIRECTLY OVER SOUND RUSTED SURFACES! MAKE THIS TEST UNDER YOUR OWN CONDITIONS AND SEE PROOF OF PERFORMANCE!

See Rust-Oleum 769 Damp-Proof Red Primer actually applied over a badly rusted surface after simple scraping and wire-brushing to remove rust scale and loose rust in the Rust-Oleum *"rusted panel demonstration."* Rust-Oleum's specially-processed fish oil vehicle *penetrates* rust to bare metal usually eliminating sandblasting and other costly surface preparations.

Rust-Oleum finish coatings in Aluminum, Green, White, Gray, Yellow, Black, Orange, Blue and others provide both *Rust Prevention* and *Decorative Beauty!* Specify Rust-Oleum for new construction, maintenance, and re-modeling. See Sweets for complete catalog and nearest Rust-Oleum Industrial Distributor, or attach coupon to your business letterhead.

RUST-OLEUM®
STOPS RUST!

There Is Only One Rust-Oleum. It Is Distinctive as Your Own Fingerprint. Resists Rain, Sun, Fumes, Snow, Heat, Salt Air, Salt Water, etc.

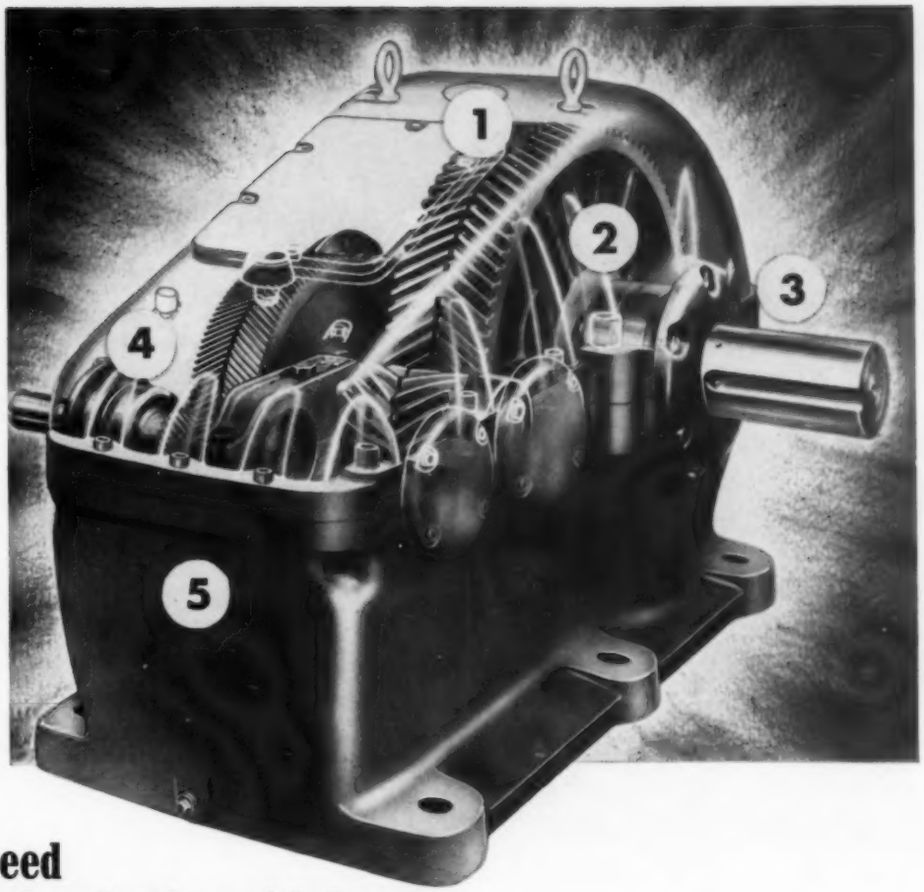
See local classified telephone directory under Rust Preventives or Paints for nearest Rust-Oleum Industrial Distributor.

ATTACH TO YOUR BUSINESS LETTERHEAD AND MAIL TO:
Rust-Oleum Corporation, 2442 Oakton St., Evanston, Ill.

- ☐ Please Show Me the Rust-Oleum "Rusted Panel Demonstration."
- ☐ Test Application of Rust-Oleum Over Rusted Metal Surfaces in My Plant.
- ☐ Complete Literature with Color Chart.
- ☐ Nearest Rust-Oleum Industrial Distributor.

LINK-BELT PARALLEL SHAFT DRIVES offer 5 big quality extras

1. **GEARS** are precision-shaved. All shafts are rigidly supported to preserve alignment far beyond rated capacity.
2. **ROLLER BEARINGS** are used throughout. Sizes are adequate to handle heavy shock and overhung loads.
3. **GREASE-LUBRICATED SEALS** prevent entrance of dirt and water. Seal housing design provides heavy grease collar for each input and output shaft.
4. **AUTOMATIC SPLASH LUBRICATION** reliably supplies oil to all bearings, gears and pinions at all speeds.
5. **STURDY HOUSING** is designed so all parts can be removed without disturbing base, which can be grouted in concrete.



When you need high-hp speed reduction with heavy shock loads, Link-Belt gives you

everything you want in PARALLEL SHAFT DRIVES

BECAUSE they withstand heavy shock loads, Link-Belt parallel shaft drives are the low-cost answer for many high-hp speed reduction problems. Simultaneous engagement of several teeth assures smooth operation and great load carrying capacity.

What's more, the elimination of power-wasting vibration results in sharply reduced power consumption. Other benefits include quiet operation and increased efficiency.

Link-Belt parallel shaft drives are available in 2.84:1 to 318:1 reduction ratios, ½ to 1000 hp, 2 to 600 output shaft rpm. Ask for Book 2519.

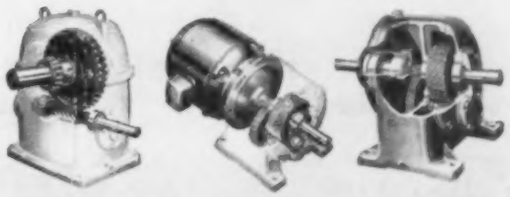
LINK-BELT

ENCLOSED GEAR DRIVES 13,408

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

WHY PRE-INTEGRATED LINK-BELT DRIVES CUT YOUR POWER TRANSMISSION COSTS

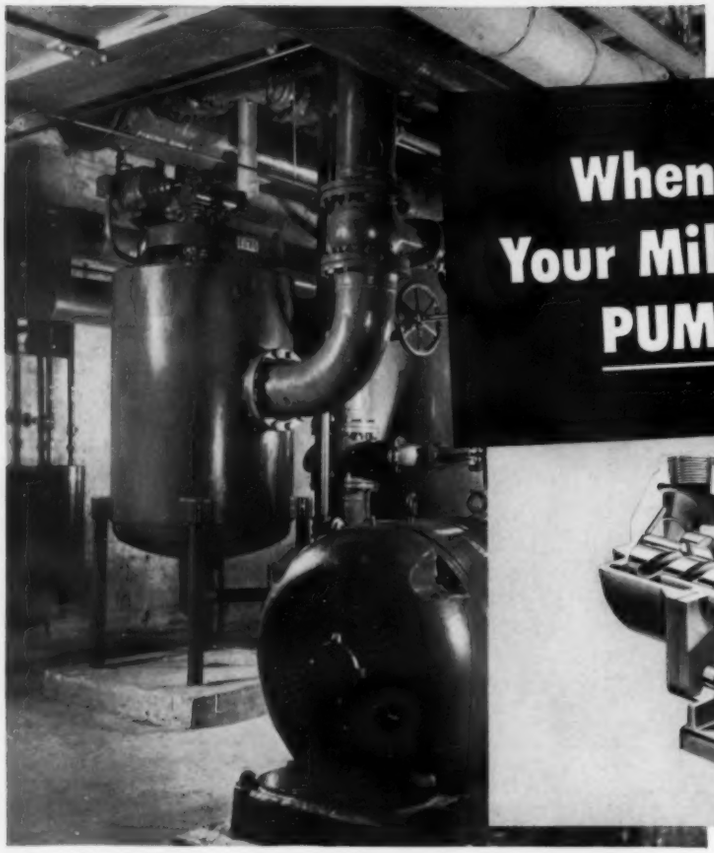
In addition to all three types of speed reducers, Link-Belt builds variable speed drives, fluid drives, chains, sprockets, couplings, bearings, shafting. All are pre-engineered for easy installation and maximum efficiency.



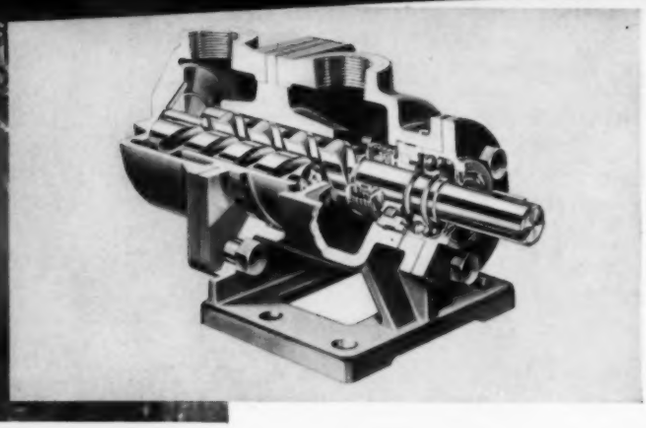
Worm Gear Drives — ask for Book 2324-A

Gearmotors — ask for Book 2247

Helical Gear Drives — ask for Book 2451



When De Laval Designs Your Mill Lubrication System PUMPS Are Important



ALL DE LAVAL ENGINEERED MILL LUBRICATION SYSTEMS HAVE THESE SPECIFIC FEATURES

1. Proper Selection of Pipe Size
2. Correct Metering of Lubricant
3. Efficient Temperature Control
4. Purification of Lubricating Oil

For Large Mills:
Custom-built Lubrication System

For Capacities up to 50 gpm:
The self-contained Unilube
Single..Simplex..Double..Dual

No piece of auxiliary equipment used in a custom-designed De Laval mill lubrication system is more important than the pump, because a constant streamline flow of the correct quantity of lubricant at the correct pressure must be maintained at all times. There are many pumps on the market that fulfill all mechanical requirements and that will work with complete satisfaction on these De Laval custom-built systems. Among the best is the De Laval-IMO, a product of the De Laval Steam Turbine Company.

Full axial flow guarantees pulsation-free delivery, thereby making De Laval-IMO pumps especially adaptable to systems where long pipelines are unavoidable. A third feature that makes them valuable on mill lubrication service is the lack of pilot gears, sliding vanes or reciprocating parts.

The study given by De Laval engineers to the selection of the right pump for each job is typical of the care given to engineering **every** detail precisely.

● ***Write for Bulletin 500.***

THE DE LAVAL SEPARATOR COMPANY
Chicago POUGHKEEPSIE, N.Y. San Francisco

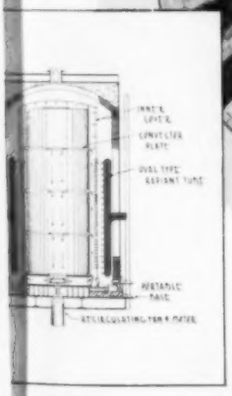
•

DE LAVAL SALES & SERVICE, INC.
447 Fourth Ave., Pittsburgh 19

DE LAVAL ENGINEERED SYSTEMS

here's the amazing "O" tube

that reduced annealing costs



The remarkable efficiency of the Lee Wilson Single-Stack Portable-Base Annealing System is due in a great degree to the new "O" type radiant tube. The tube, developed by Lee Wilson especially for the bell type furnace, is an engineering accomplishment.

The design of the tube allows greater length of flame travel and the fuel application is so arranged that the principal heat release is in the bottom of the tube. The flame, however, is continued around the top elbow, changing the direction of the gas flow, keeping the primary combustion near or on the tube surface, effecting more efficient heat transfer. The sharp turns designed into the tube not only make it a compact, space-saving unit but create a gas turbulence at the elbows that promotes more rapid combustion; thus, more of the tube is working. The "O" Tube has a much greater dispersion area than other tubes and can operate at an input of 500,000 BTU per tube, per hour.

The design of the tube also permits perfect blanketing of inner cover, speeding heating time and eliminating hot and cold spots. Structurally, the tube has the advantage of not requiring holes in the furnace arch and but one opening in the side wall. It is free to expand in every direction, preventing excessive force which might crack the joints.

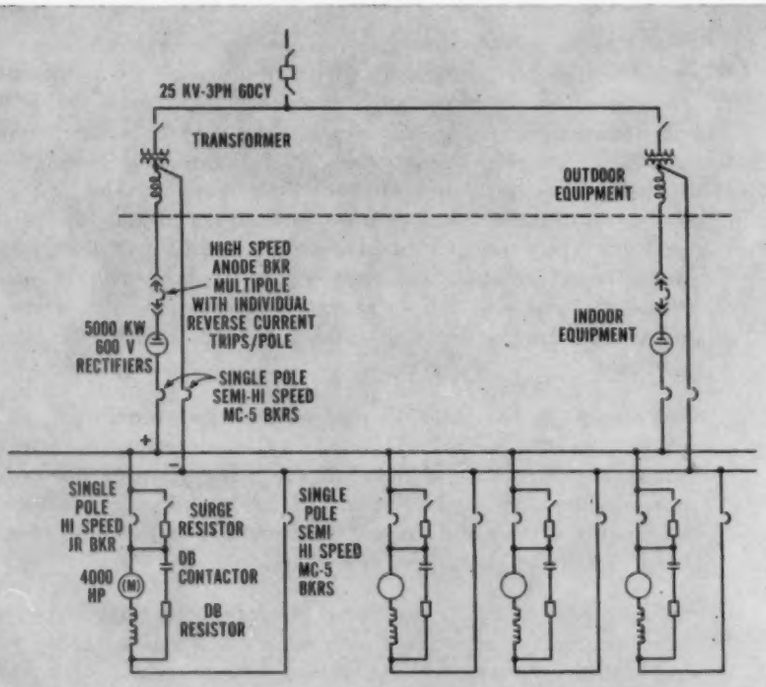
There's a lot more to the story! Performance records prove this tube has no equal when it comes to quality production annealing. It's the furnace of the future — here today. Brochure and data sheets available upon request.

Lee Wilson

ENGINEERING COMPANY, Inc.

20005 WEST LAKE ROAD, CLEVELAND 16, OHIO

FEW INSPECTIONS ARE NEEDED. Here, the motor room attendant checks vacuum of rectifier equipment. Maintenance is reduced because rectifiers have few moving parts. Further, since rectifiers are static, heavy foundations are not needed.

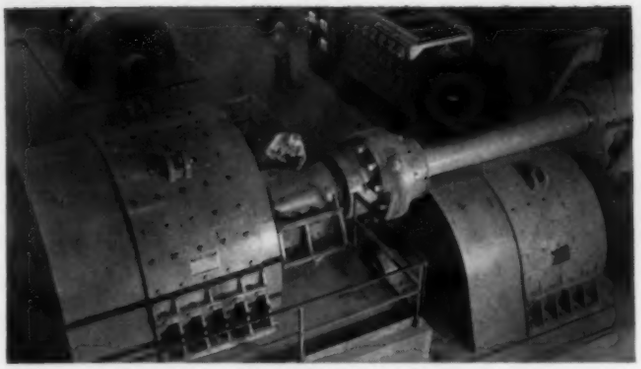


HOW THIS DRIVE WORKS

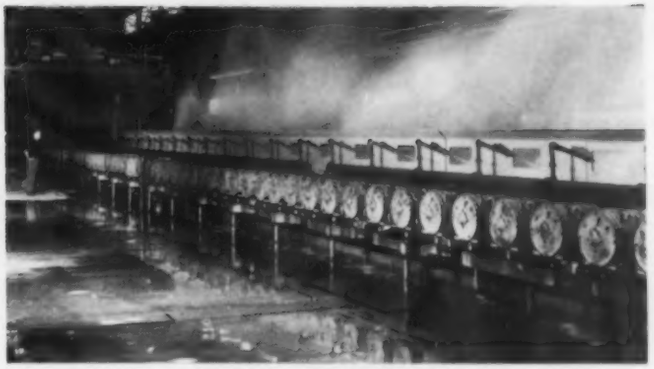
All motors are connected to a common 600 volt bus, supplied by two 5000-kw rectifiers. The voltage on this bus is held constant during rolling operations by amplistat-type voltage regulators, which combine accuracy and fast response with simplicity, dependability and low maintenance. The amplistat, as well as the rectifier ignition circuit, is completely static—no moving parts.

High-speed multipole draw-out type anode breakers are used to interrupt rectifier arc-backs and reclose automatically without interfering with continuity of power supply or voltage regulation. Additional fault current protection and flexibility of operation is provided by rectifier cathode and transformer neutral semi-high speed single pole breakers. High speed breakers with surge cushioning resistors and semi-high speed breakers insure a high degree of protection for the stand motors.

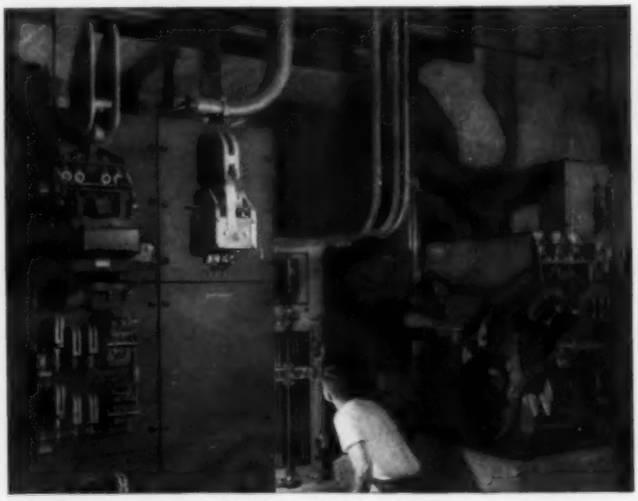
Another example of G-E drive engineering at work!



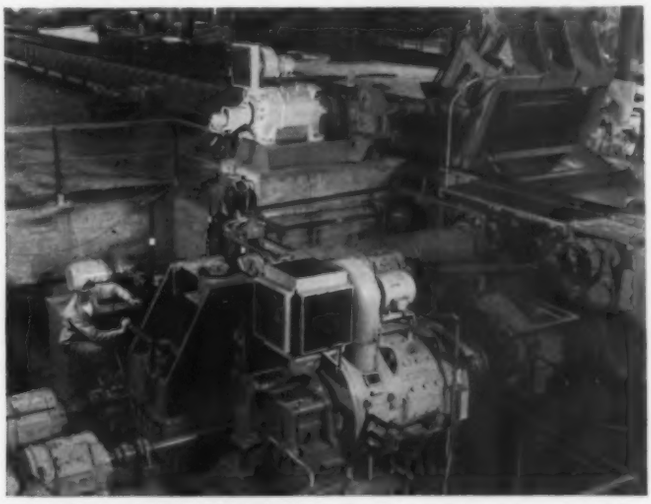
SLAB THICKNESS IS REDUCED 90% by a 4-high reversing rougher and vertical edger in five to seven passes. Twin 3000-hp motors drive mill; a 600-hp motor powers edger.



INDIVIDUAL RUNOUT-TABLE MOTORS—177 3-hp Type MDY's, specifically designed for this type of service, are part of 2500 horsepower of d-c auxiliary motors supplied.



CO-ORDINATED HIGH-SPEED Type JR and semi-high speed Type MC-5 breakers help safeguard against damage from flashover or overload of finishing train main drive motors.



COILER IS SPEED-MATCHED to last mill stand and runout tables. An improved tension regulator and a separate generator for the pinch roll help improve quality and increase tonnage.

Main drives of Pittsburgh Steel's new mill powered by G-E rectifiers

Part of complete G-E system, these efficient units power finishing train of 66" hot-strip mill

A highly efficient type of conversion system—using two mercury arc rectifiers—has been installed by the Pittsburgh Steel Company to supply d-c power for the finishing train of their new semi-continuous hot-strip mill at Allenport, Pa.

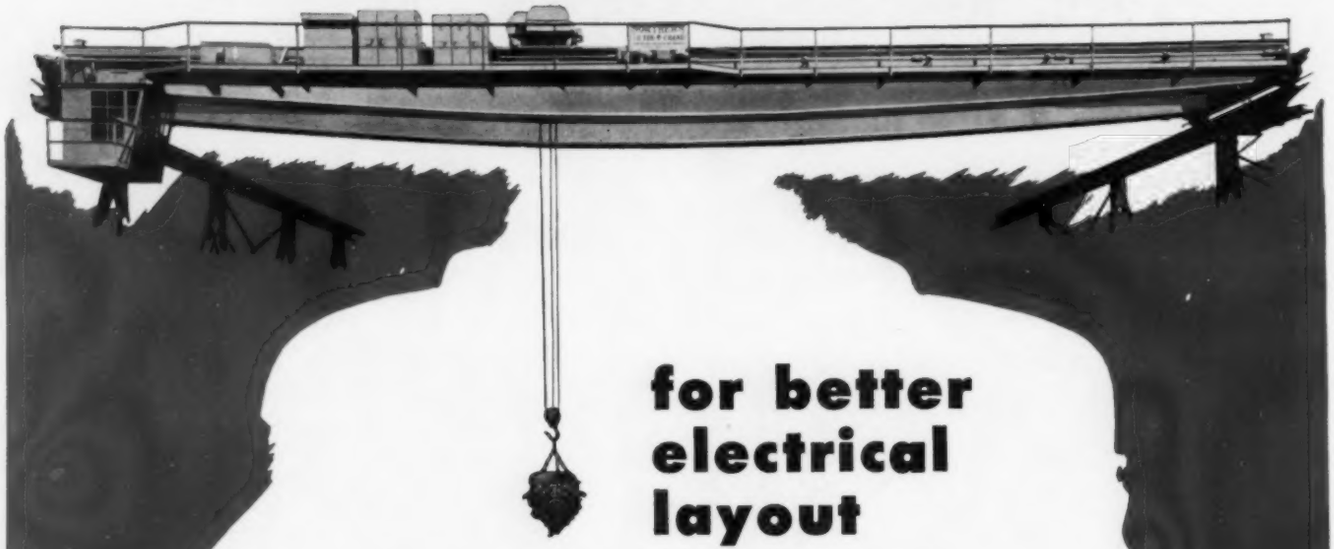
It's the third time rectifiers alone—controlled by magnetic amplifiers—have been used in the United States for such service. Two pumped rectifiers each rated at 5000-kw, convert power from 25,000 volts, 3-phase, 60-cycle a-c to 600 volts d-c. This power drives four G-E 4000-hp finishing stand motors. Strip 66 inches wide can be rolled at a present top speed of 1770 feet per minute.

The Allenport mill's rectifier system was patterned after a G-E "first" which has been in service for more than three years. These rectifiers, like the rest of the power equipment throughout the mill, were selected after careful engineering study. Engineers from Pittsburgh Steel, G.E., and United Engineering & Foundry teamed up to co-ordinate this electric equipment into one smoothly functioning system. These engineers also made provision for future expansion—two more finishing stands and an additional coiler can be easily added whenever needed.

If you are planning to modernize or expand any of your facilities, take a tip from Pittsburgh Steel. Call on G-E steel mill specialists early during the planning stage. General Electric Company, Schenectady 5, N. Y. 659-99

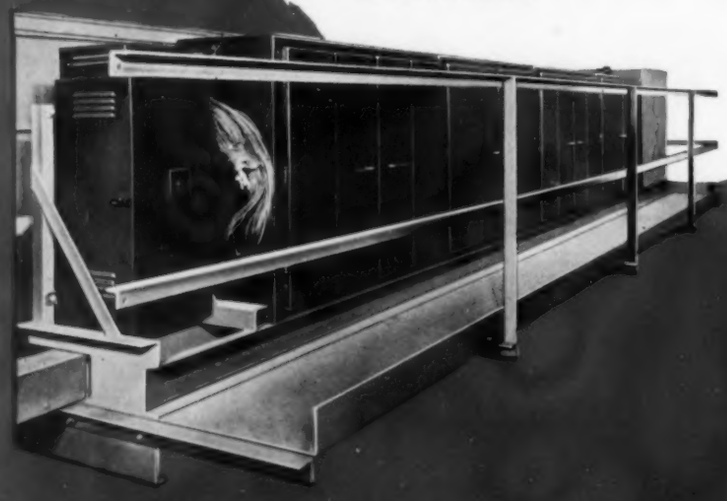
GENERAL ELECTRIC

Northern Cranes

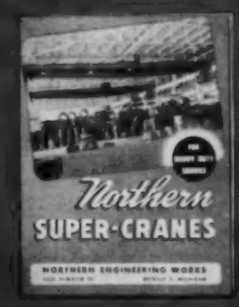


for better electrical layout

- Magnetic control panels mounted on a common support and wired as a unit greatly simplifies crane assembly, accessibility and maintenance.
- All wires, where possible, contained in metal raceways having movable covers.
- All Northern Cranes are completely wired at factory with solderless connectors, to eliminate the usual field soldering.
- Unit-welded steel construction, heavy duty roller bearings, transmission gear reductions, minimized wear on moving parts, easy accessibility, quick lubrication, simplified maintenance, and many other features reflect our experience of over 50 years in crane engineering and manufacture.



Write for new Super-Crane Bulletin SE-108-160



NORTHERN ENGINEERING WORKS

General Offices: 2615 Atwater St., Detroit 7, Michigan

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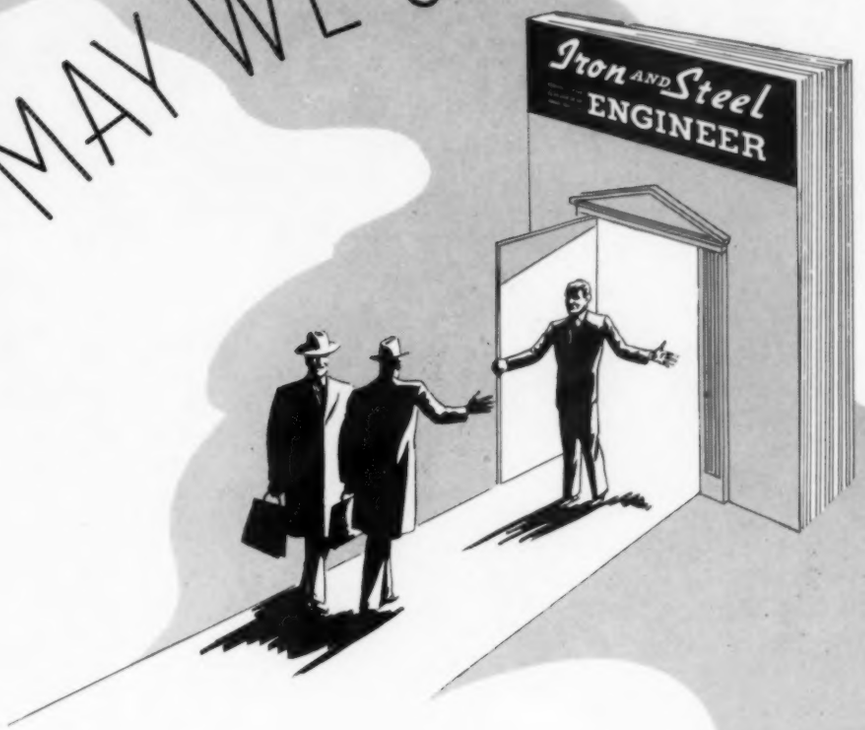
MAY WE COME IN?



We are NEW to the regular readers of Iron and Steel Engineer though we have been serving the Steel Industry for over 30 years. We are designers and builders of heavy duty, mill type, industrial oil hydraulic equipment. We regularly furnish valves, cylinders, pumping and control equipment, complete hydraulic systems and special purpose hydraulic machinery.

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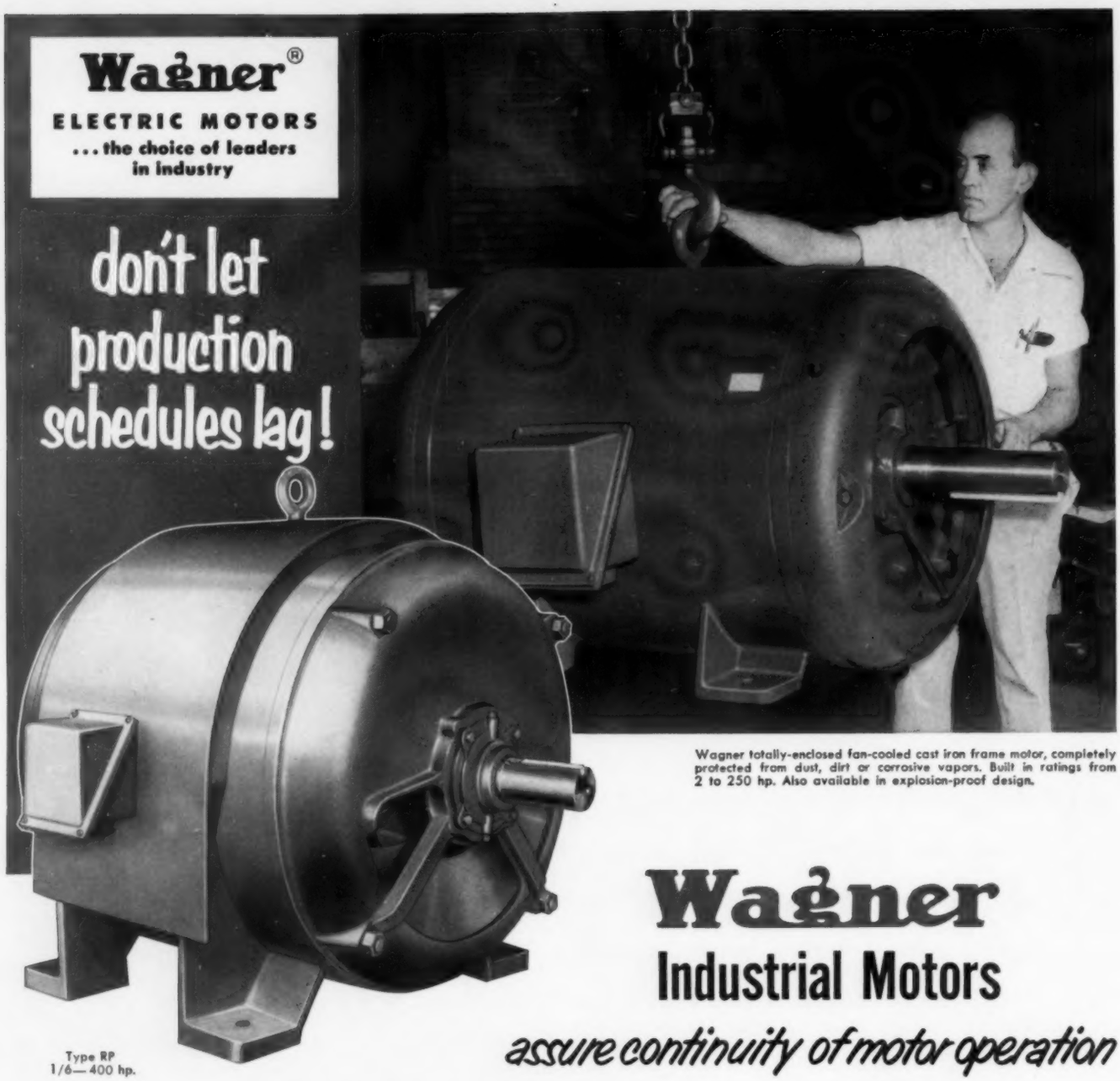

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SUPEREX® high temperature block insulation has long been industry's No. 1 choice for service temperatures up to 1900F. It provides *major* economies . . . reduces fuel costs, cuts heat losses, keeps maintenance expense down, costs less to install and has long service life.

These are the reasons why 90% of the nation's hot blast stoves are Superex insulated . . . and why the low cost open hearth steel producers use Superex in their regenerators.

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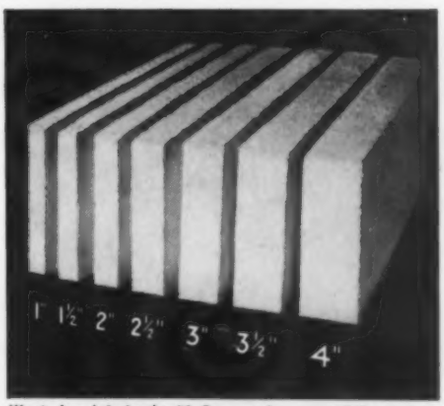

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Even in a period such as the past five years of accelerated activity in new construction, Koppers has repaired 1,100 ovens for 20 major steel companies. These companies have found that there is a basic economy in bringing to bear on their repair projects our engineering skills and experience that date back to 1926.

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Your industrial air conditioning problem is solved with DRAVO'S COMPLETE LINE OF EQUIPMENT

If your working area is subject to radical temperature variations and unhealthy atmospheric conditions, there's a Dravo air conditioning unit specifically designed to eliminate these hazards.

Dravo industrial air conditioning equipment filters the air, removes dust, dirt and fumes; heats in the winter, cools in the summer and provides year around ventilation.

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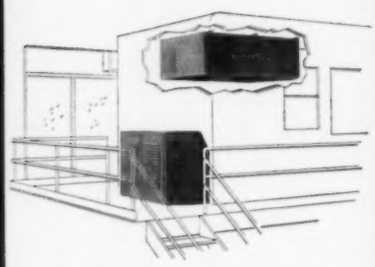
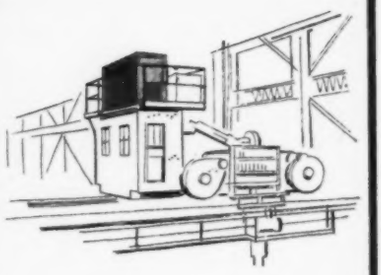
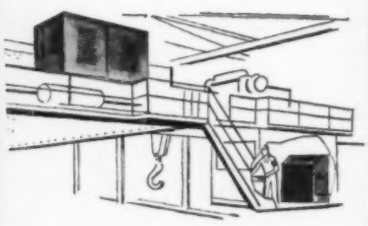


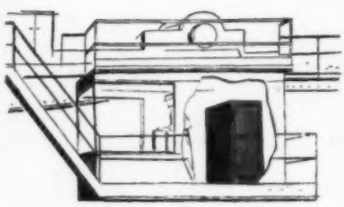
NEW PULPIT AIR CONDITIONER for blooming mill, strip mill, rod mill pulpit and many other industrial applications. Maintains 80-85°F in summer and 68-72°F in winter. Evaporator section is mounted inside the pulpit with a suitable cabinet for controls. Condenser section is located outside wherever convenient. Refrigerant piping joins the two sections.



SELF-CONTAINED CRANE CAB COOLERS—mounted alongside the cab or on the cab roof. Only electrical leads and connections required. Thermostat control—fully automatic—maintains 85°F temperature with ambient temperatures up to 175°F. Ideal for installation on all types of cranes working over "hot spots" in steel and other metal-working industries.



SPLIT-TYPE CRANE CAB COOLERS—installed in two sections—the heavy condenser unit on the crane wherever you want it—the light cooling section in the cab with the operator. Two sections joined only with refrigerant pipe and electrical connections.



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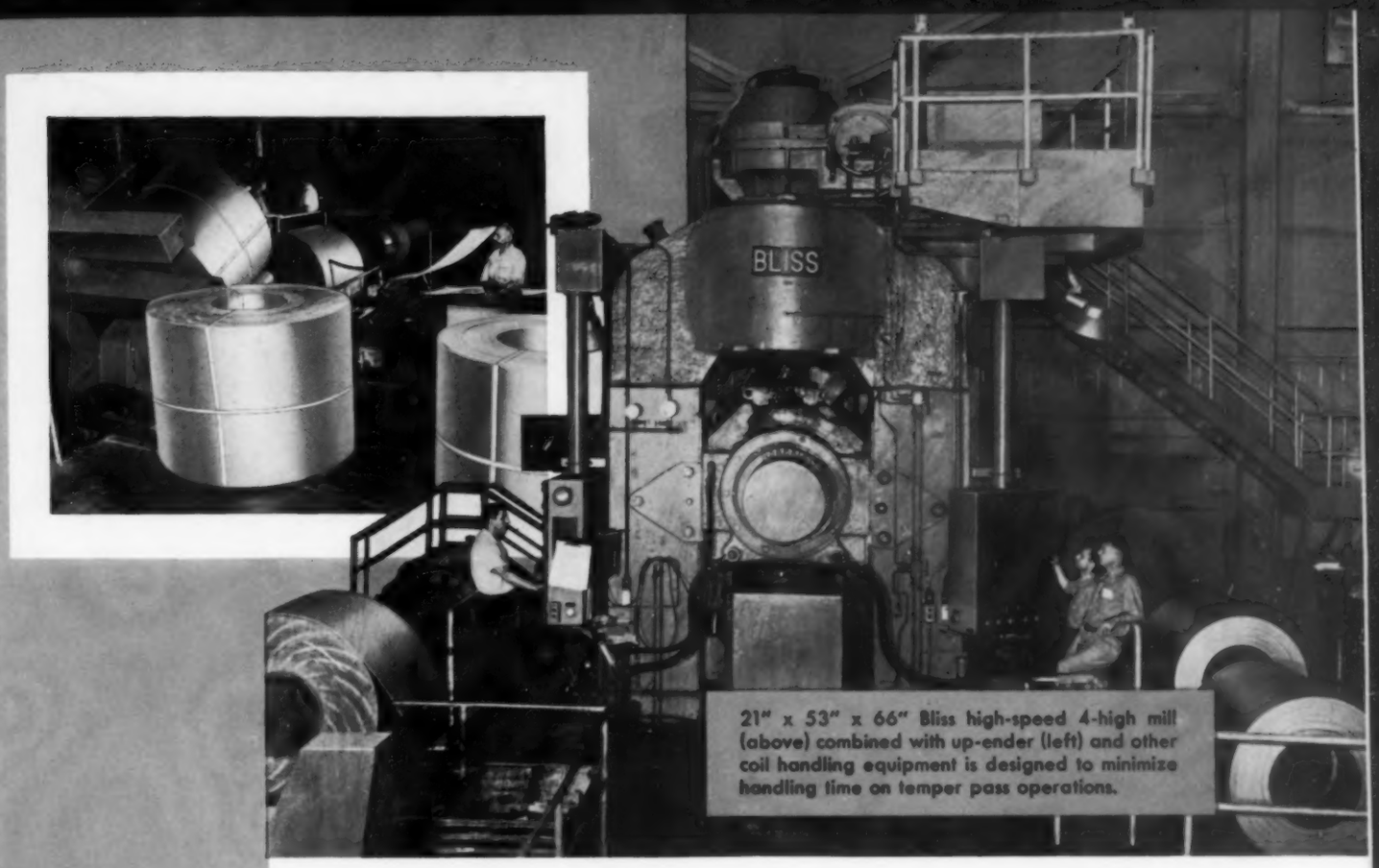

21" x 53" x 66" Bliss high-speed 4-high mill (above) combined with up-ender (left) and other coil handling equipment is designed to minimize handling time on temper pass operations.

BLISS mill at the Ford steel plant designed to give OPTIMUM MILL USE

Looking for ways to cut down on idle rolling mill time? Most metal producers are. Then consider the recent Bliss installations at Ford Motor Company's great Rouge plant where the new Bliss 4-High Temper mill was designed to do just that.

Bliss engineers approached the problem by combining the most advanced coil handling equipment and electric controls with a new high-speed mill. The entire installation was engineered to Ford's rigid requirements for providing optimum mill use on temper pass rolling. Here's how Bliss designed to meet these specifications:

Speedier coil handling—entry conveyors, up-ender, coil positioning and preparation cradle, and reels operate faster; give unprecedented protection to coil edges and operating personnel.

Heavier coils used—weighing up to 56,000 lbs. each, in maximum 60" widths, and maximum 72" O.D.; larger coils mean less frequent "threading".

Continuous Strip inspection—facilitated by special electric devices and engineered vantage points of inspection.

Roll changeover is quick and easy—with motorized equipment.

Screwdown settings and adjustments—made more quickly due to highly powered electric equipment with fine control.

If you have a mill equipment problem, do as other leading mill users do. Consult BLISS. Meanwhile, write for your copy of our revised 60-page brochure. Bulletin 40-A.

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U. S. Plants in Canton, Salem and Toledo, Ohio; and Hastings, Michigan. Branch Offices in Chicago, Cleveland, Dayton, Detroit, Indianapolis, New Haven, New York, Philadelphia, Rochester, Toledo; and Toronto, Canada. West Coast Representatives: Moore Machinery Co., Los Angeles and San Francisco; Star Machinery Company, Seattle. Other representatives throughout the world.

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Jet Engine Parts

The parts that go to make up a jet engine call for heat treating techniques as new as they are varied. Drever's long experience, through its own commercial heat treating division, has provided welcome solutions to many new problems of furnace design encountered in this field. Drever builds heat-treating furnaces of many types, with special adaptability to treating Stainless Steels of the 300 and 400 series, as well as Nimonic, etc.

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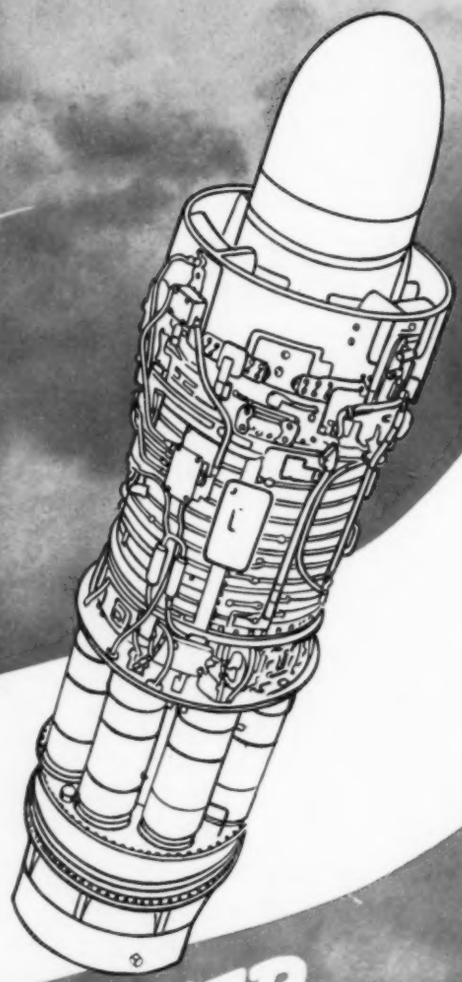

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8

Patent Reviews

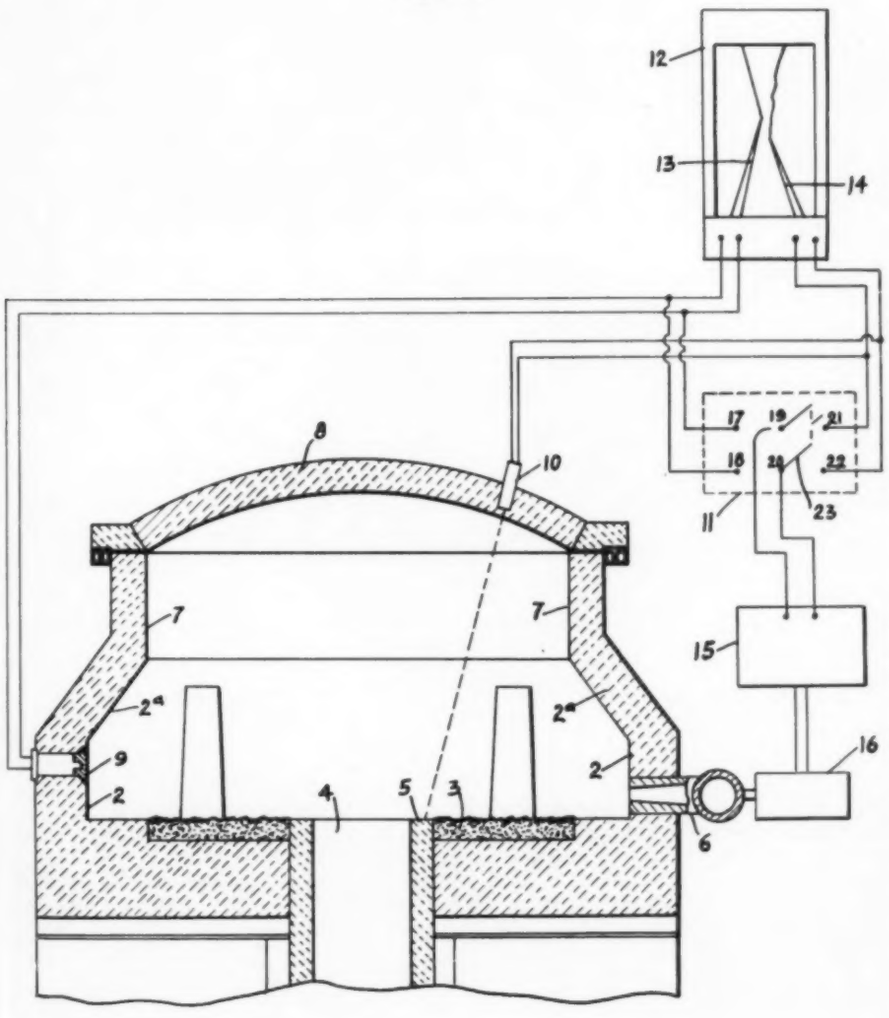
By MELVIN NORD
Patent Attorney
Detroit, Mich.

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . patents reviewed cover period October 13, 1953 through November 3, 1953 . . . .

▲ IN U. S. 2,656,172, issued October 20, 1953 to Frank C. McGough, a method of regulating the heat supplied to a soaking pit is described.

Figure 1 shows the soaking pit with a transfer switch and a temperature recorder-controller. A burner opening 6 is provided in a side wall 2 of the soaking pit. At a suitable location in the side wall is a pyrometer 9, responding to the temperature of the space between the ingot and side wall of the soaking pit. It is connected to terminals 17 and 18 of the transfer switch 11. When these are connected to 19 and 20, the pyrometer actuates the temperature controller 15 and burner regulator 16. The pyrometer is also connected in parallel to the recorder 12 so as to operate the side wall temperature recording arm 13.

Figure 1



The recorder has a second arm 14 which is actuated by the temperature of the space in the vicinity of gas outlet opening 4 at the center of the soaking pit: hence it responds more or less directly to the temperature of the effluent gases. A radiation pyrometer 10 focused on the refractory curb 5 serves this purpose.

The first method of controlling the operation of the soaking pit requires that the transfer switch be set so that the temperature of the outlet gas controls and the temperature of the side wall only records. This is accomplished by connecting terminals 21 and 22 to 19 and 20 through the switch. The soaking pit is charged and fired as usual, the initial firing rate being at the full rate, until pyrometer 10 indicates that the outgoing gases have reached the rolling temperature. In the meantime, the side wall temperature is much higher than the rolling temperature. The rate of combustion is now reduced and this temperature at the outlet port is maintained constant at the rolling temperature by the control.

The temperature recording for the side wall will gradually drop. When it equals the outlet port temperature, the steel is ready for rolling.

In Figure 2, typical chart readings for this type of control are given. The dotted line represents the outgoing gas temperature, and the solid line the side wall temperature.

In the second method of control, terminals 17 and 18 are connected to 19 and 20 through the switch, so that the side wall temperature records and controls, and the outgoing gas temperature only records. Control is set so that the side wall temperature is limited to the maximum furnace temperature allowed, which is above the rolling temperature and is determined by the maximum temperature to which either steel or furnace may be safely subjected. When this side wall temperature has been reached, it is automatically maintained constant, by reduction in the heating rate. When the outgoing gas temperature reaches the rolling temperature, control is manually or automatically transferred by the switch 23 so that the gas temperature (set to control at rolling temperature) controls. The side wall temperature then gradually drops to rolling temperature, and the metal is ready for rolling. This type of control is shown in Figure 3.

The invention is based on the discovery that only when the ingots are properly soaked will the temperature of the outgoing gases substantially coincide with the temperature of the ingot.

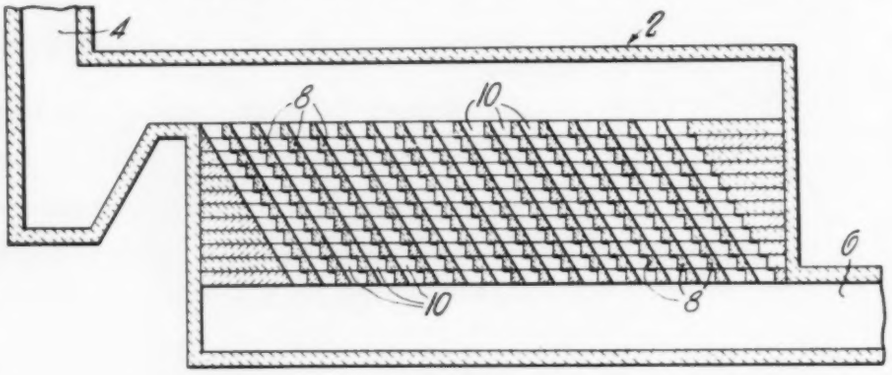


Figure 4

CHECKER WORK FOR HEAT REGENERATORS

In U.S. 2,655,366, issued October 13, 1953 to John C. Stanley, and assigned to United States Steel Corp., a regenerator checkerwork is provided in which the flues are closed passageways having a large heat transfer area and are inclined at an angle from the vertical.

Figure 4 is a schematic view of a furnace regenerator having this type of checkerwork. Figure 5 is a sectional view, showing a checkerwork of standard brick and skewback brick constructed according to the inven-

Figure 2

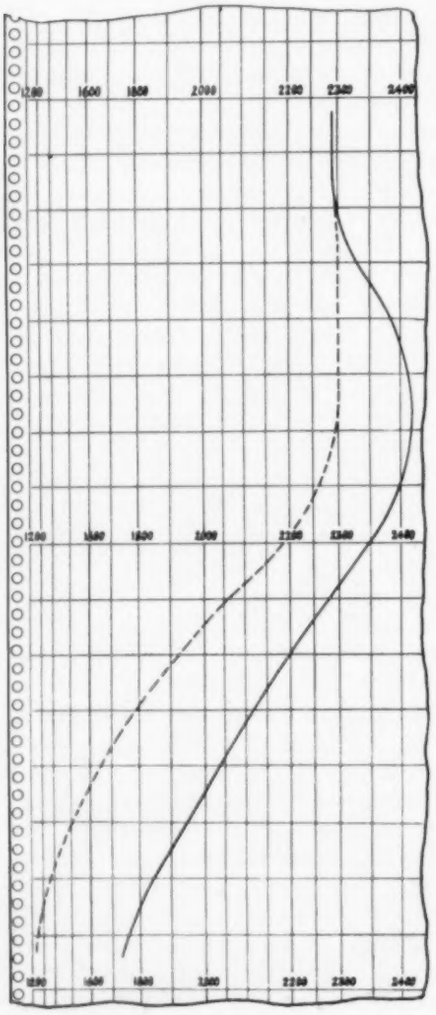
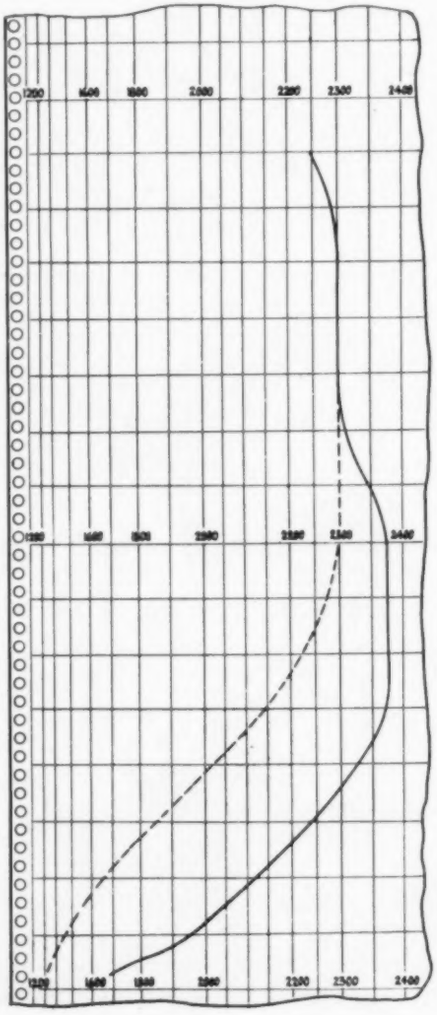


Figure 3



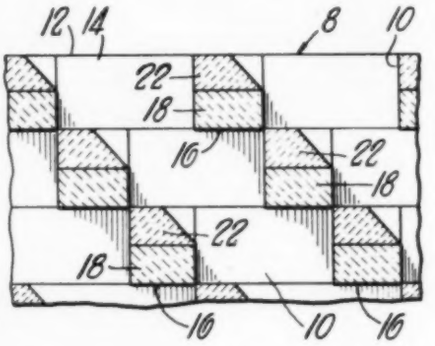
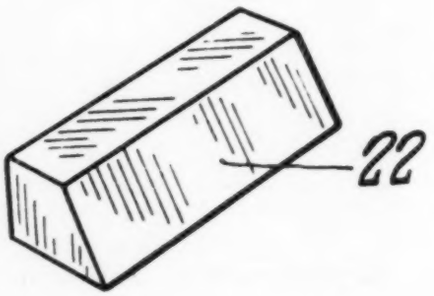


Figure 5

Figure 6



WHY SHELL-MOLDED BRONZE BEARINGS COST LESS AND WEAR LONGER

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Add to this the fact that if oil grooves are required, they can be cast in; if drilling is specified, castings are drilled prior to shipment so that they are ready for installation when received by you . . . and you have the answer to why *shell-molded* bearings cost less and wear longer.

And remember, six modern National Bearing plants insure quality workmanship and prompt delivery. They, in turn, are backed by extensive engineering and research facilities of the entire American Brake Shoe Company.

So investigate National SM castings for use as line shaft, crane, run-out table, and other similar replacement parts.

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AMERICAN Brake Shoe COMPANY

NATIONAL BEARING DIVISION
4930 Manchester Avenue, St. Louis 10, Mo.

tion. Figure 6 shows a skewback brick such as is used in Figure 5. An alternative arrangement is shown in Figures 7, 8, and 9. In this case, inclined face brick such as that shown in Figure 10 are used.

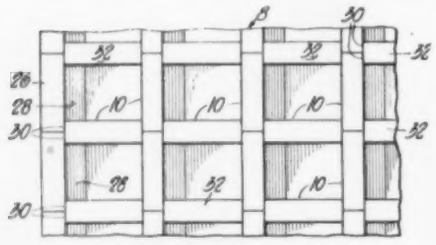


Figure 7

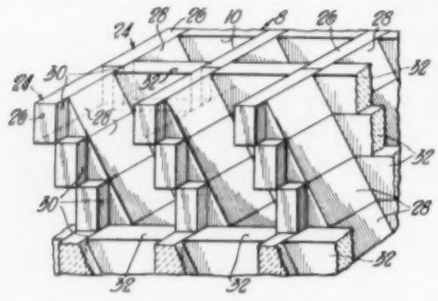


Figure 8

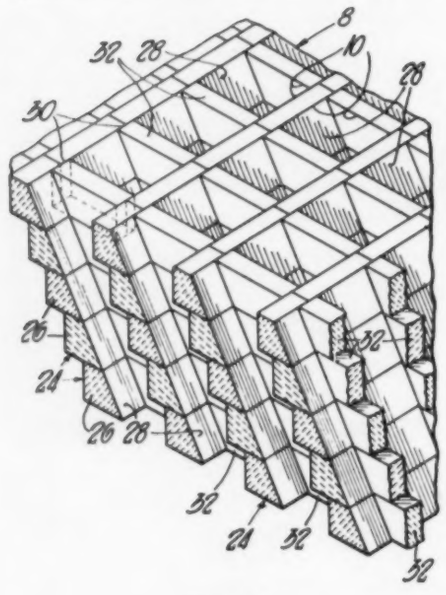
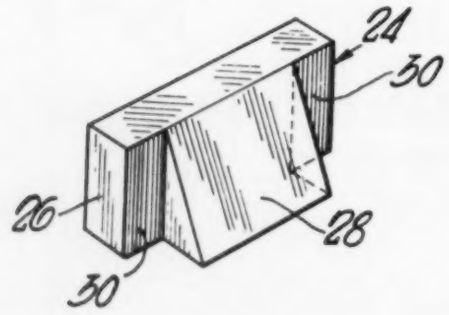


Figure 9

Figure 10



It is claimed that this type of construction provides an increase in the heat-transfer area of the flues, and increases turbulence without impeding the flow of fluids.

PRODUCTION OF COATED SOFT IRON AND STEEL SHEETS

The object of U.S. 2,656,285 is to provide a rapid and inexpensive process whereby soft iron and steel sheet stock having the softness of hot rolled and annealed products may be produced from materials which have been cold reduced. The patent was issued October 20, 1953 to Robert S. Burns and Robert L. Solter, and was assigned to Armco Steel Corp.

The apparatus used in carrying out the invention is shown in Figure 11.

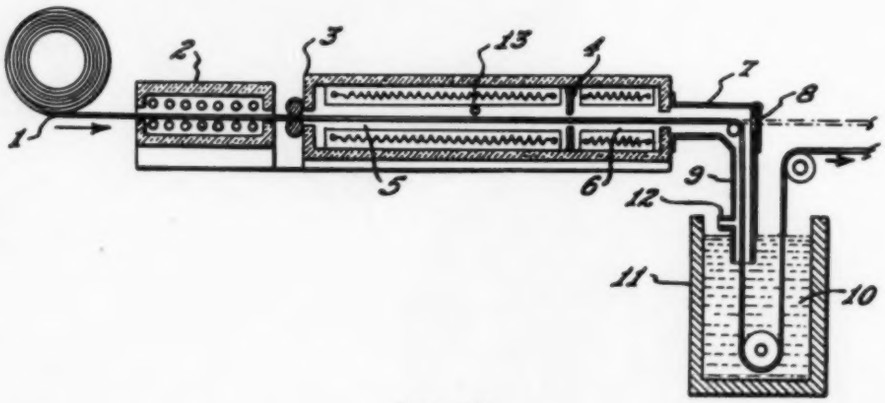
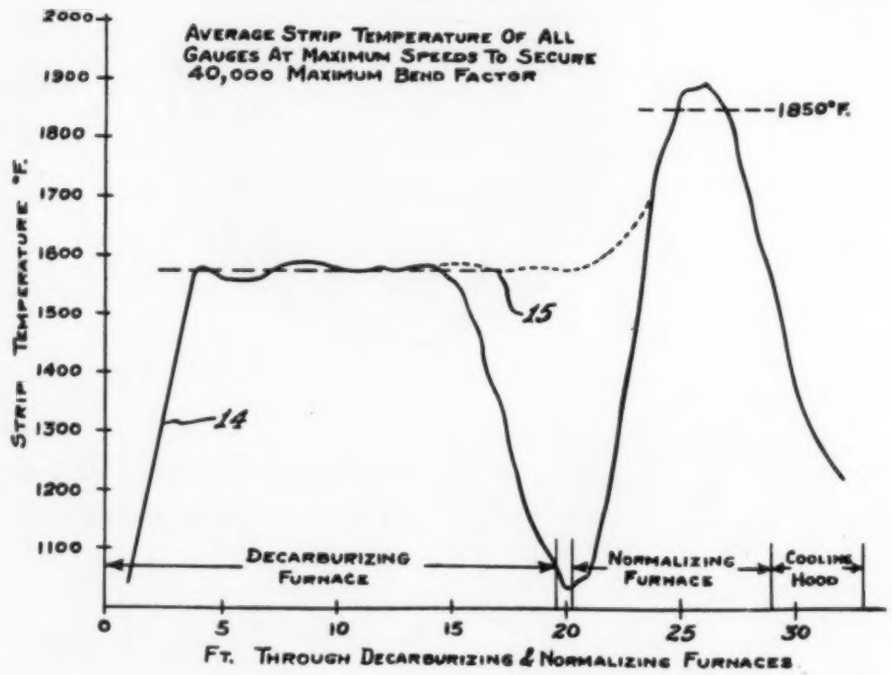


Figure 11

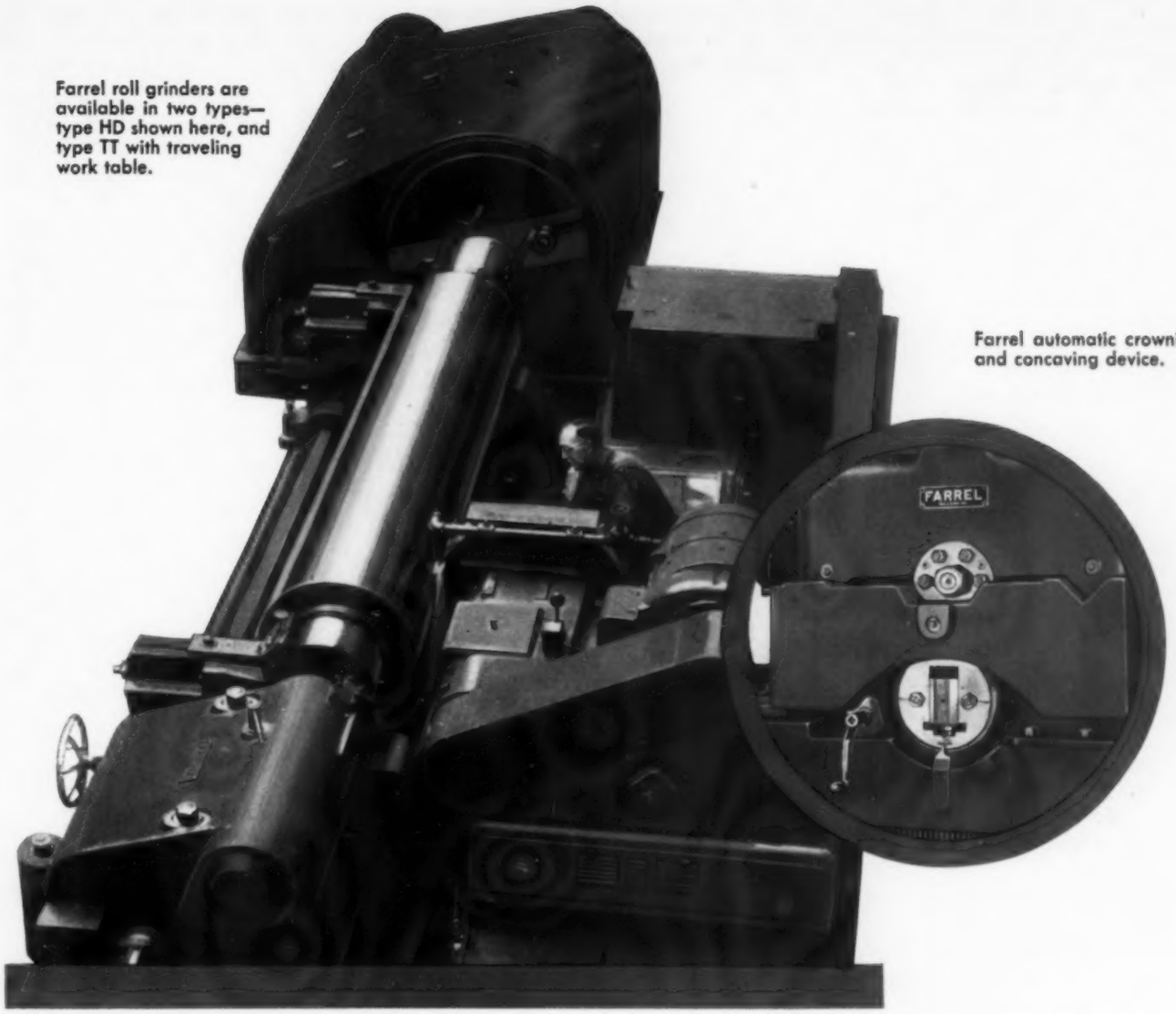
A metal strip 1 is cleaned by passing through a short oxidizing furnace 2, in which the oil is burned from its surfaces. The strip next passes to a furnace 3, which is divided into parts by baffles 4. The first portion of the furnace 5 is that in which decarburizing takes place in a moist atmosphere containing hydrogen. The second portion of the furnace 6 is the portion in which the metal is heated above the A_3 point. A cooling hood 7 is provided with a closable port 8, permitting the direct removal of the treated strip. Alternatively, the strip may pass through a molten coating metal 10 in a coating pot 11.

Figure 12 shows typical temperature conditions during the carrying out of the process. The solid line shows temperatures in the case where separate decarburizing and normaliz-

Figure 12



Farrel roll grinders are available in two types—type HD shown here, and type TT with traveling work table.



Farrel automatic crowning and concaving device.

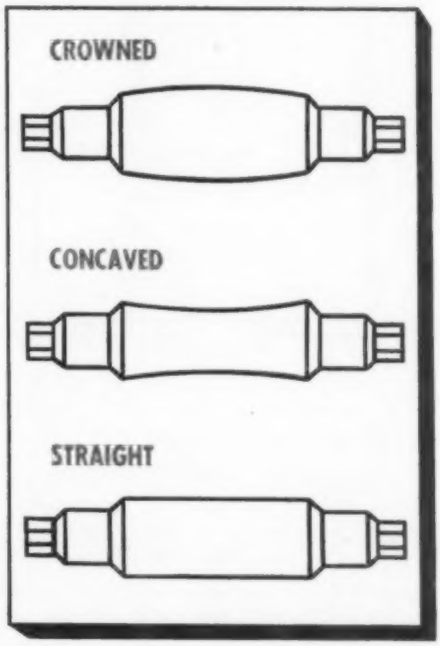
MATHEMATICALLY PRECISE ROLL CONTOUR

can be *this* simple!

Each Farrel® heavy duty roll grinder is equipped with an automatic crowning and concaving device. This built-in "brain" guides the grinding wheel along a perfectly graduated, mathematically accurate curve. Crowned or concaved rolls are ground with both halves perfectly symmetrical.

The grinder, once this device is adjusted, will produce exactly the curvature desired, without any further manipulation on the part of the operator. The same setting invariably produces exactly the same curvature, permitting uniform and easily controlled accuracy of contour.

Accurate "curve control" is only one of the many outstanding features of a Farrel heavy duty roll grinder. Write for descriptive bulletin giving full details.



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FB-893

Farrel-Birmingham ®

ing furnaces are used; the dotted line refers to the use of a single furnace as described above.

The invention is based on the discovery that if iron or mild steel sheet stock is decarburized to 0.01 per cent or less, and then raised above the A_3 point, the material develops a coarse grain structure with considerable softness. This is the opposite of the result obtained by normalizing conventional material.

OXYGEN LANCING OF FURNACE FLUES AND CHECKERS

In U.S. 2,657,034, issued October 27, 1953 to Thomas A. Thompson and assigned to National Steel Corp., dust is removed from furnace flues and checkers by impinging a stream of oxygen-rich gas against the dust deposit under operating temperatures. The dust deteriorates into a residue of fine particles and gases which are carried up the stack by the draft. The gas should contain at least 90 per cent oxygen in order to have the desired effect. The gas is applied through a lance.

BLAST FURNACE MONKEY

In the operation of a blast furnace, it is necessary to draw hot slag from the furnace by removing the plug in the center of the monkey installed in the furnace. The conventional type monkey is a casting inserted in the furnace, which casting is cooled by

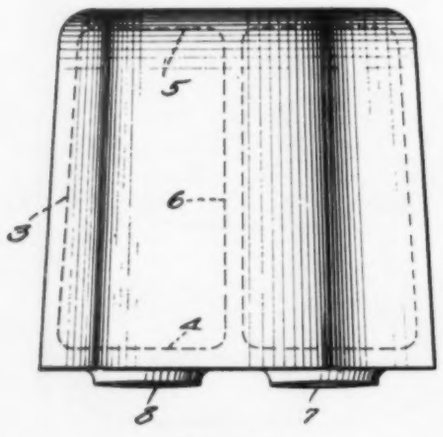


Figure 13

an annular water space within the monkey and having an opening through the center of the monkey which is closed by a plug. Experience has shown that the action of inserting and withdrawing the plug for the purpose of drawing off slag, coupled with the intense heat from the flowing slag, enlarges the original opening in the

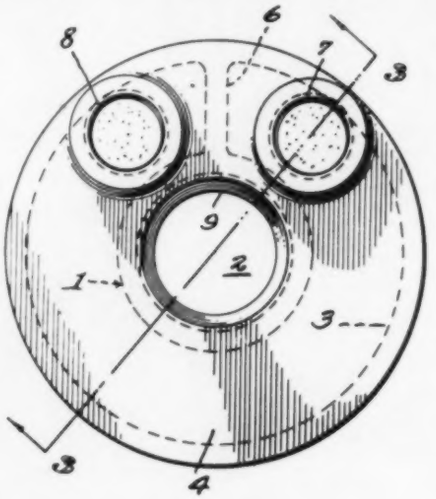


Figure 14

monkey. As a result, the wall thickness between the opening in the monkey and the annular water space is reduced until it ruptures. This requires shutting the furnace down every three to four days while the ruptured monkey is replaced with a new one.

In U.S. 2,657,922, issued November 3, 1953 to J. B. Casey and Grady A. Smitherman, and assigned to Woodward Iron Co., the monkey is constructed so as to have an increased useful life. The apparatus is shown in Figures 13, 14, and 15, these views being respectively a top plan view, a front elevation, and a section along lines 3-3 of Figure 14.

The monkey is formed with an inner wall 1 having a bore 2 opening at opposite ends. The bore 2 is tapered, the large end being at the front end of the monkey. An outer wall or jacket 3 surrounds the inner wall. The water space is closed at opposite ends by walls 4 and 5. A partition 6 is provided in the water space, extending from front to rear of the monkey. Inlet and outlet openings 7 and 8 permit water circulation.

The novelty of the invention resides in forming on the surface of the bore 2, at the large end of the bore an annular rib or boss 9, defining a circular cylindrical surface. The inner wall 1 is of the standard thickness (3/8 in.), while the thickness of the annular boss is 1/8 in.

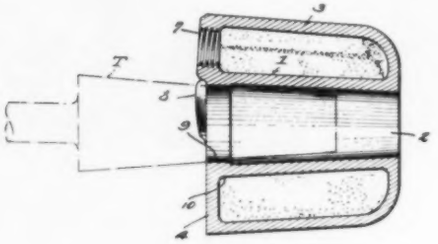
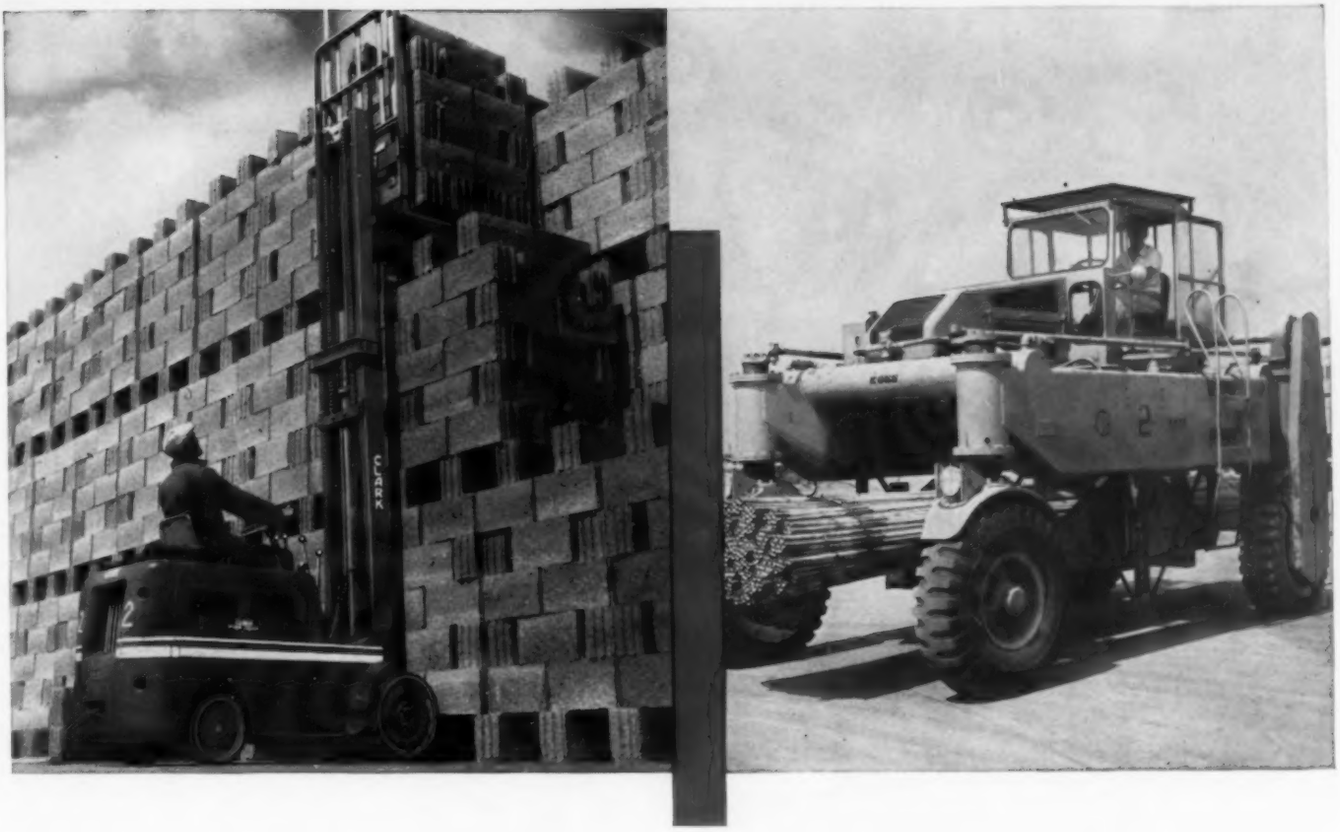


Figure 15

In blast furnace monkeys of conventional construction, rupturing of the inner wall 1 takes place approximately at location 10. It was found in actual practice that the useful life of conventional monkeys in three particular blast furnaces averaged 4.1 days, while with the new type of monkey, it averaged 14.2 days.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,655,263	10/13/53	Ore pulp concentrator	Ferros Metals Research Co., Ltd.
2,655,363	10/13/53	Furnace valve construction	Jay L. Roof
2,655,364	10/13/53	Production of hot blast for blast furnaces	Societe Anonyme John Cockerell
2,655,436	10/13/53	Tank for treating waste pickle liquor	United States Steel Corp.
2,655,473	10/13/53	Electrolytic detinning of tin plate	Metal and Thermit Corp.
2,655,823	10/20/53	Rolling of tapered sheets	Hydropress, Inc.
2,655,986	10/20/53	Burner of the projected flame type	Inland Steel Co.
2,656,055	10/20/53	Means for charging scrap metal	Levi S. Longenecker
2,656,171	10/20/53	Furnace for heating crucibles	George E. Markley
2,656,267	10/20/53	Removal of silicic matter from iron	Inland Steel Co.
2,656,284	10/20/53	Method of plating rolled sheet metal	The Commonwealth Engineering Co.
2,657,036	10/27/53	Cooling apparatus for annealing metal sheet and strip	Jones & Laughlin Steel Corp.
2,657,130	10/27/53	High-temperature stainless steel	Armco Steel Corp.
2,657,650	11/ 3/53	Torch for cutting stainless steel	National Cylinder Gas Co.
2,657,698	11/ 3/53	Quenching apparatus	Selas Corp. of America
2,657,976	11/ 3/53	Production of iron oxide and titanium tetrachloride from titaniferous iron ores	National Lead Co.
2,658,012	11/ 3/53	Reeling hot rolled steel rods	United States Steel Corp.



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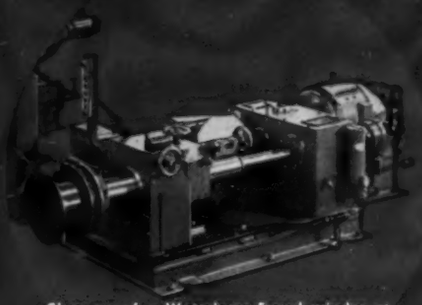

Close-up of a Waterbury Farrel winder at the delivery end of a WF Tandem Mill. Winder is provided with pneumatic clamping of reels. It has three adjustments for width of wire and width and positioning of drum or spool.

This complete Waterbury Farrel mill package includes 10" and 8½" Tandem Wire Flattening Mills, power driven double head Pay-off, Edger, Winder, footage counter, continuous thickness and width gauges and automatic electrical synchronizing control. Other WF tandems with up to five mills available.

Modern Waterbury Farrel Mill Design Insures High Production Plus Precision . . . Minimizes "Down-Time"

Here are some reasons why Waterbury Farrel Wire Flattening equipment can give you *more continuous,* high speed, precision production.

- Loading payoff and motor driven screwdowns for mills and edgers facilitate threading of wire with minimum effort and time.
- To protect precision operation, soluble oil is circulated internally and externally on the rolls and into coolant enclosures where wire is submerged. A refrigeration system maintains the coolant oil temperature at approximately 70° while a flotation unit keeps it clean and fresh. In addition, high speed mills also have a self-contained, automatically-filtered circulating mineral oil lubrication system for roll necks and drives.
- Transparent lucite covers at vital lubrication points such as gear cases and universal joints make it easy to check lubrication at a glance.
- Anti-friction bearings are used for all rotating members including the winder shaft. High precision anti-friction bearings are used on roll necks and edger arbors. This, combined with precision fitting of component parts enables WF mills to maintain tolerances well inside commercial allowance.
- Tungsten carbide ring rolls permit rolling the toughest alloys and increase roll life.
- Electric control keeps wire tension constant. Dancer rolls are used for fine wire.

Waterbury Farrel designs and builds a wide range of wire flattening mill equipment to suit specific requirements. Various sizes and combinations of single and multiple mill stands with auxiliary equipment are available for flattening ferrous and non-ferrous wire from the smallest diameters to 1" diameter and more. Speeds range up to and above 2500 FPM.

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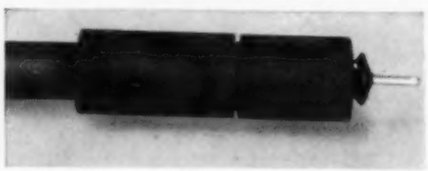
WF 9

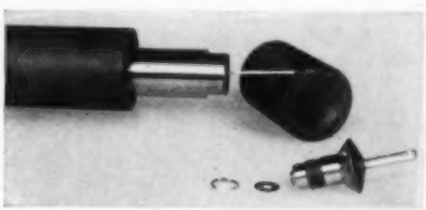
Simplified Maintenance

SPEEDS REPEATED BATH MEASUREMENTS WHEN YOU USE THE L&N IMMERSION THERMOCOUPLE

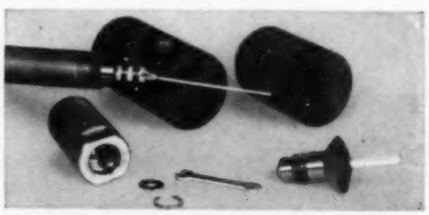
Tip of Immersion Couple ready for use. Graphite blocks, under spring tension, house the immersion end of the thermocouple element. The "hot" junction projects into the quartz sheath.



First step in replacing sheath. A retractor (not shown) releases the spring tension—exposes the tapered, stainless steel plug into which the quartz sheath is cemented.



After each immersion, the quartz sheath is replaced. Usually, a supply of sheaths, cemented into spare plugs, is kept on hand. Cement comes ready-mixed.



When the junction requires repair, terminal screws are loosened, sufficient wire is drawn down from its storage in the tube, a new junction is formed, and the unit is reassembled.

● Unique design of the L&N Immersion Thermocouple reduces routine maintenance to a simple operation performed right at the furnace. No time is wasted in elaborate repairs—or in transporting equipment to and from instrument maintenance shops. No valuable storage space is required for numerous stand-by units. No capital is tied up in surplus equipment.

After each immersion in the molten metal, the operator simply replaces the plug-mounted quartz sheath protecting the "hot" junction of the couple, and is ready for the next measurement. When the thermocouple junction itself must be repaired, an adequate length of wire is simply drawn down from the reserve supply in the tube to form the new junction.

Since each unit is normally available on a full-time basis, equipment requirements are reduced. The usual installation consists of only one unit per furnace (with one Speedomax® immersion thermocouple recorder for every two units) and a stand-by unit for every two or three furnaces.

Ease of maintenance is but one feature of the L&N equipment. Accuracy of measurement is protected in various ways. Design of the thermocouple circuit minimizes junction error by putting lead-wire junction at the handle end of the unit. Instrument accuracy is protected by automatic standardization of the recorder measuring circuit during each immersion, only seconds before the immersed couple reaches bath temperature. Simplicity of operation is assured by the Recorder's Signal Light system, which guides the user through each step of the measuring sequence.

For full details, contact your nearest L&N representative, or write us at 4942 Stenton Ave., Phila. 44, Pa. for Process Data Sheet 643(1).

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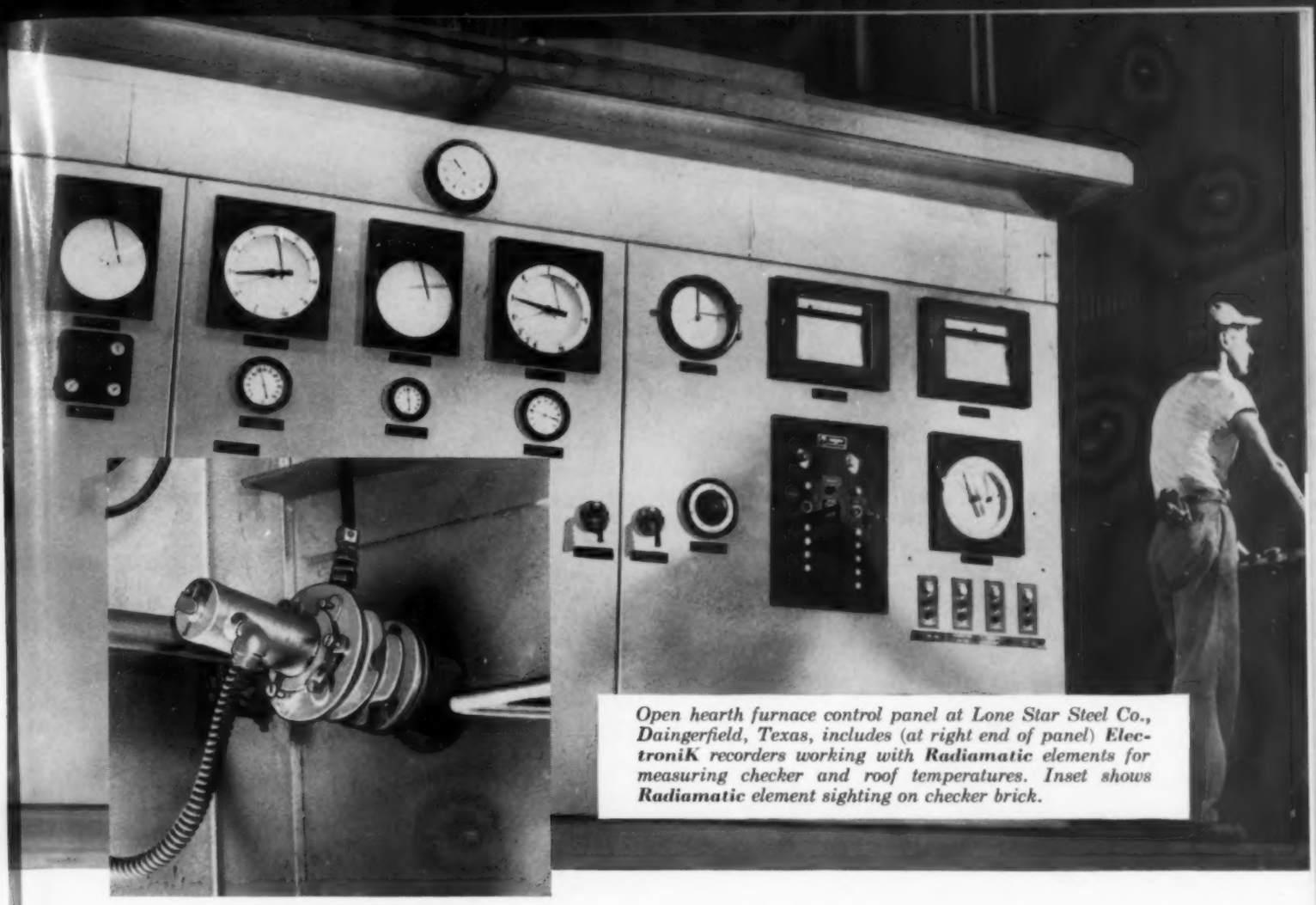

Open hearth furnace control panel at Lone Star Steel Co., Daingerfield, Texas, includes (at right end of panel) ***ElectroniK*** *recorders working with* ***Radiamatic*** *elements for measuring checker and roof temperatures. Inset shows* ***Radiamatic*** *element sighting on checker brick.*

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MINNEAPOLIS **Honeywell**

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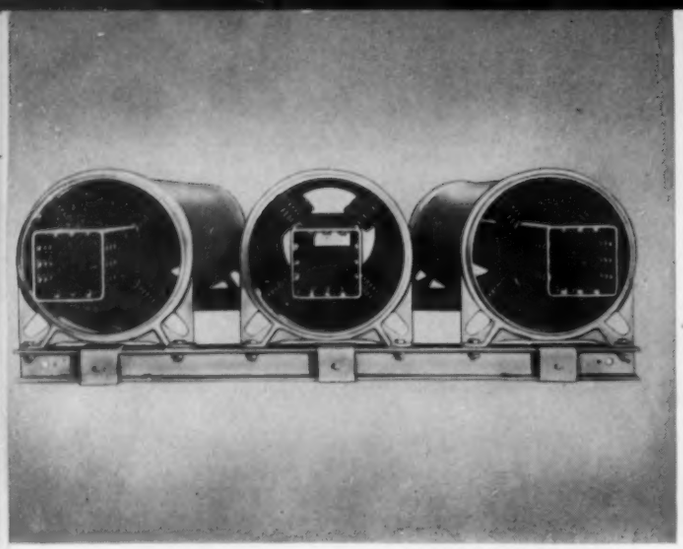

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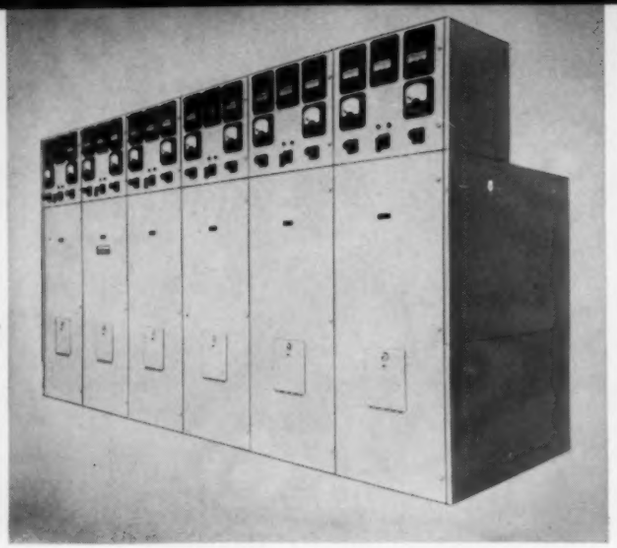

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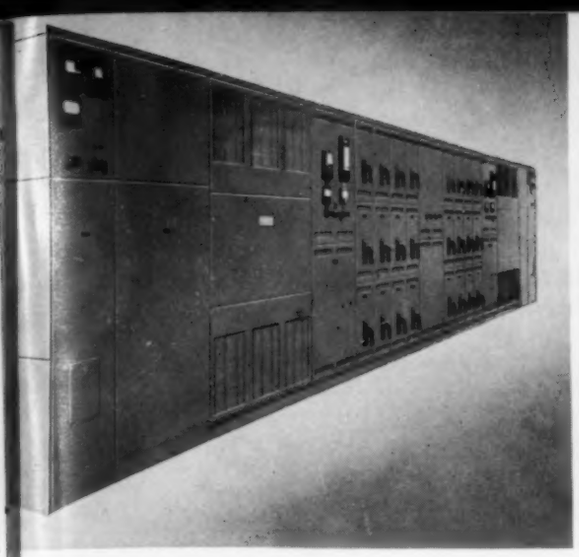

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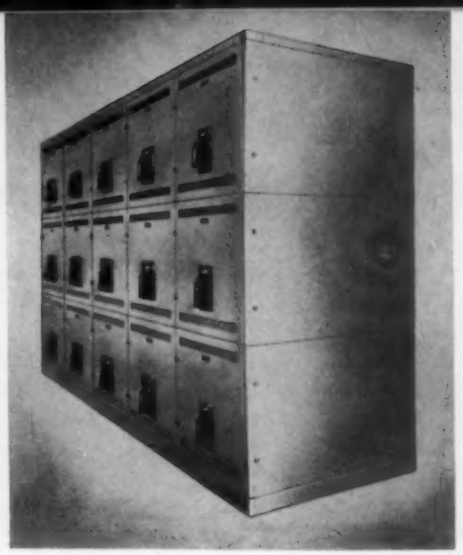

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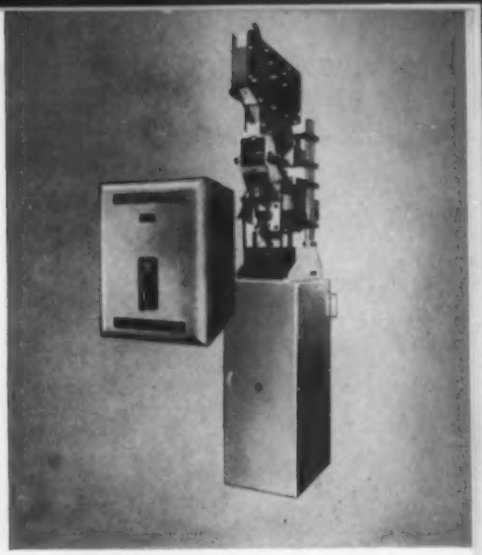

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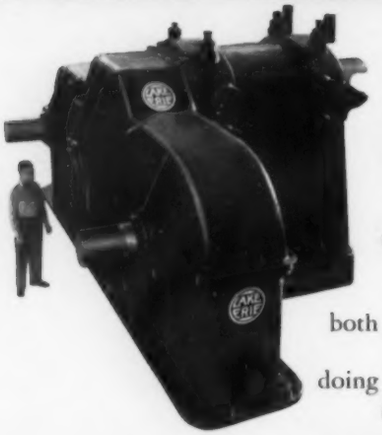

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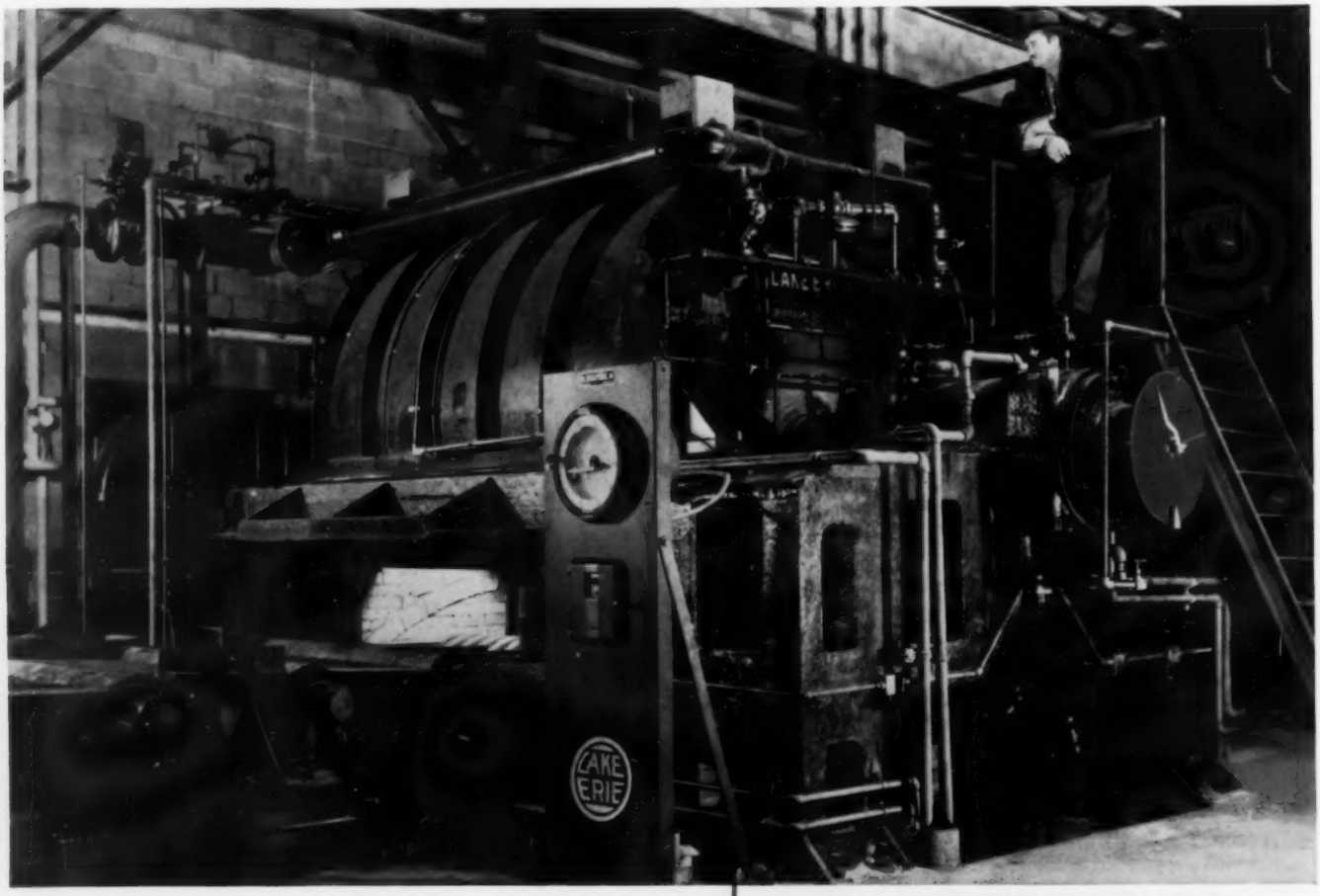

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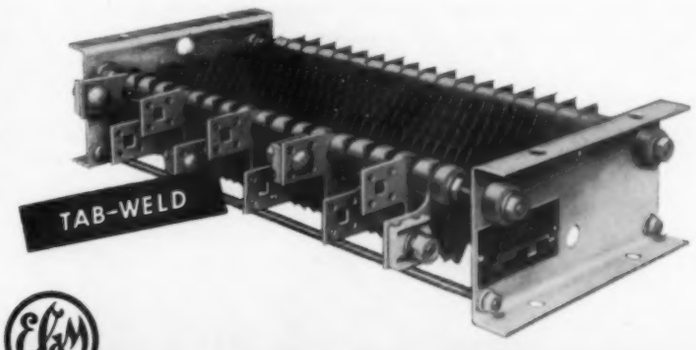

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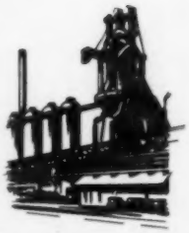

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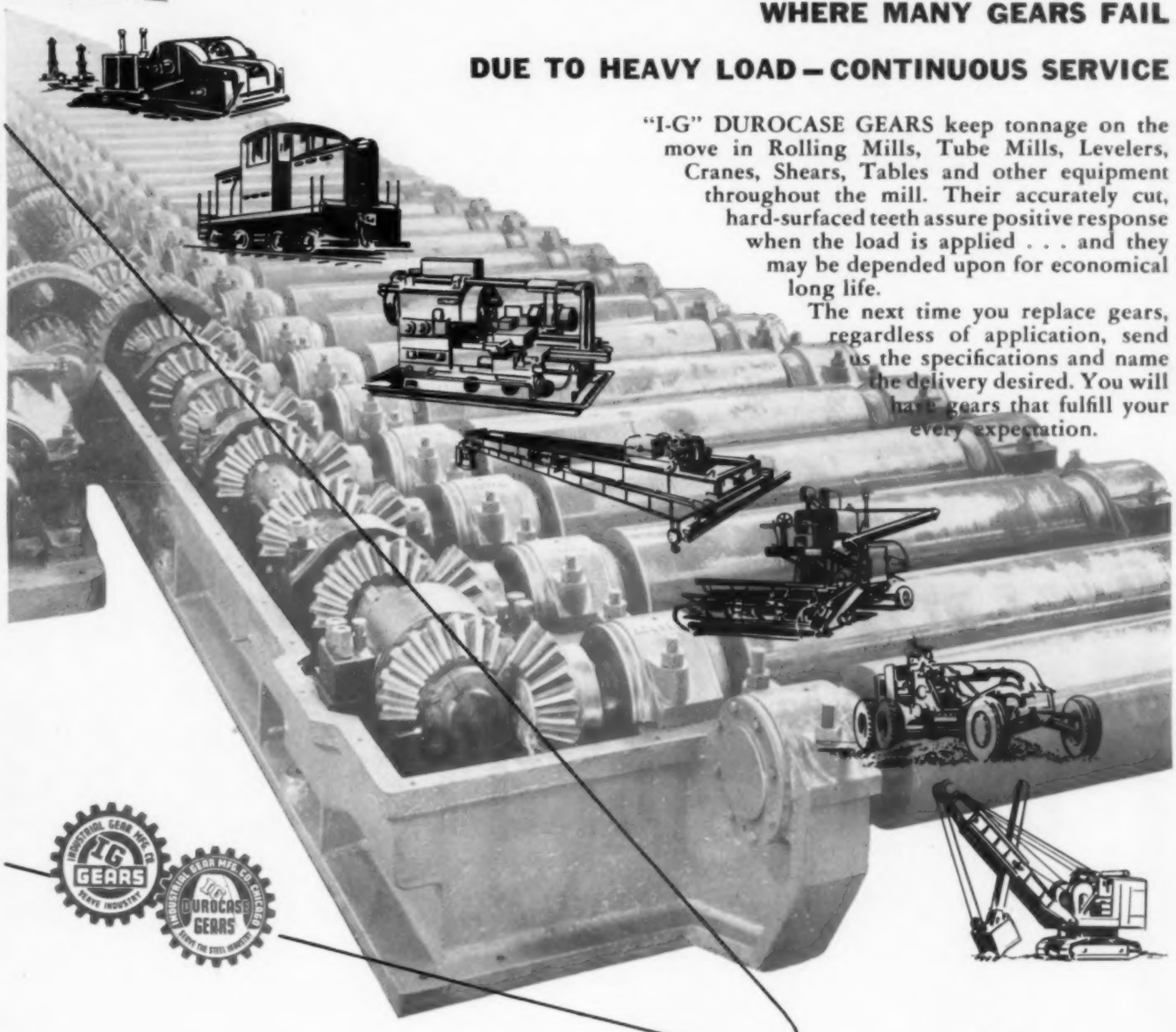

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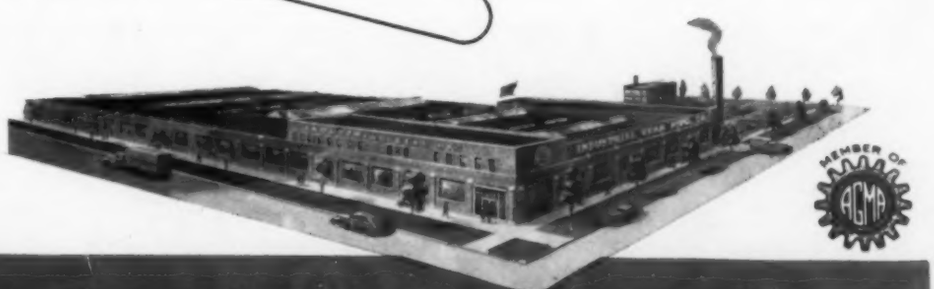

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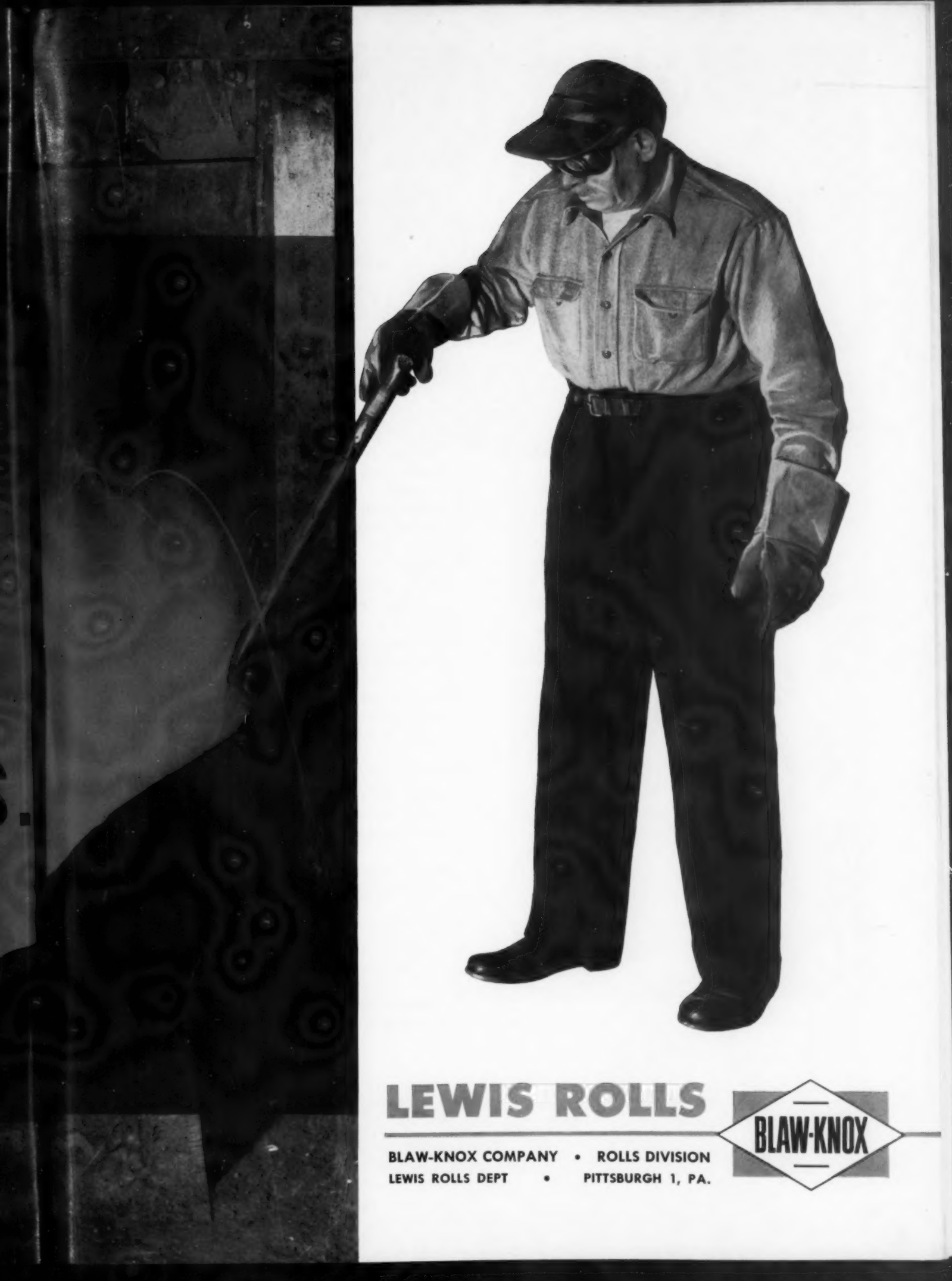

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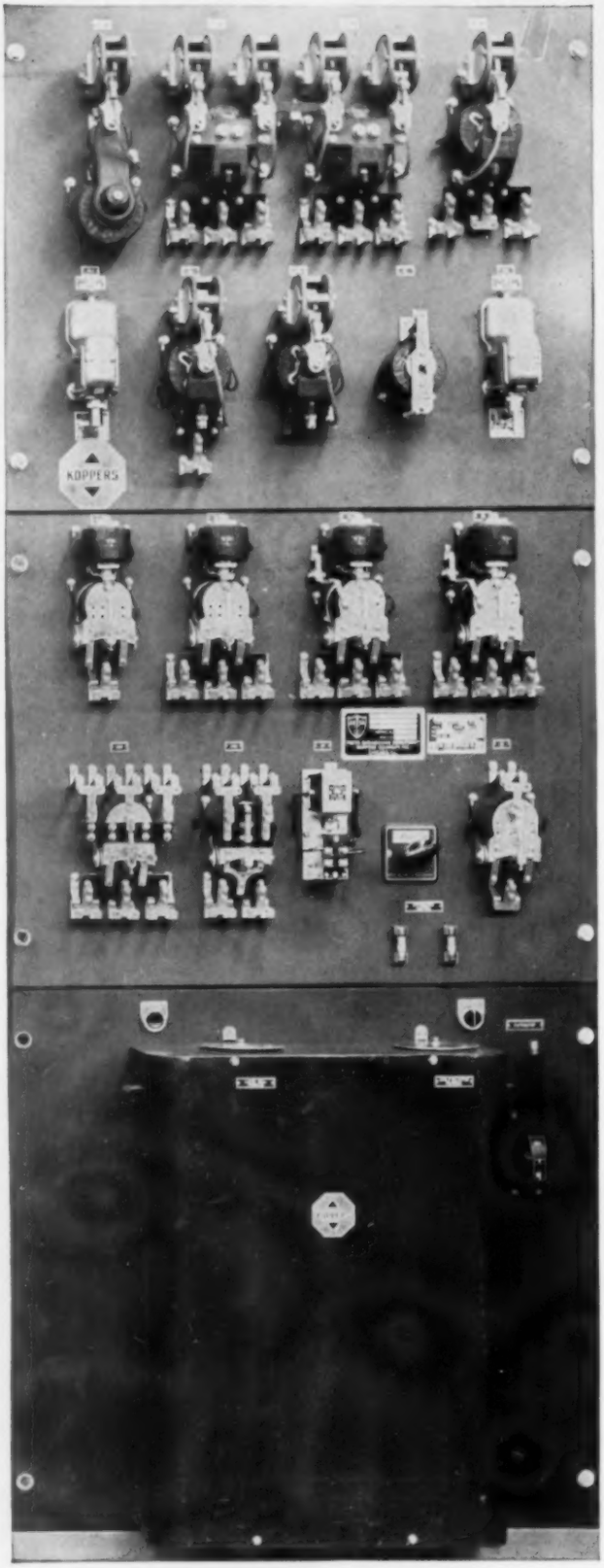

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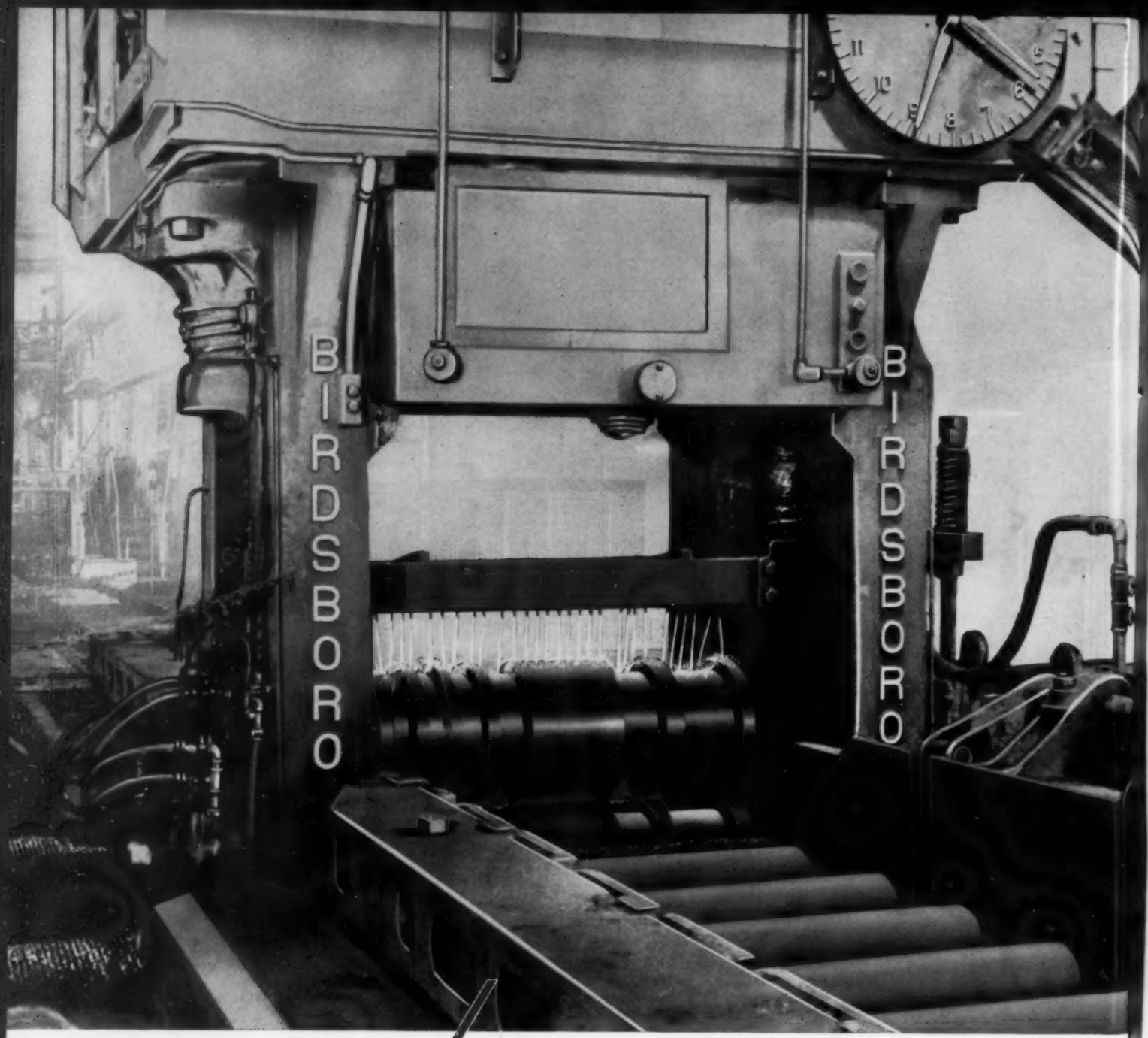

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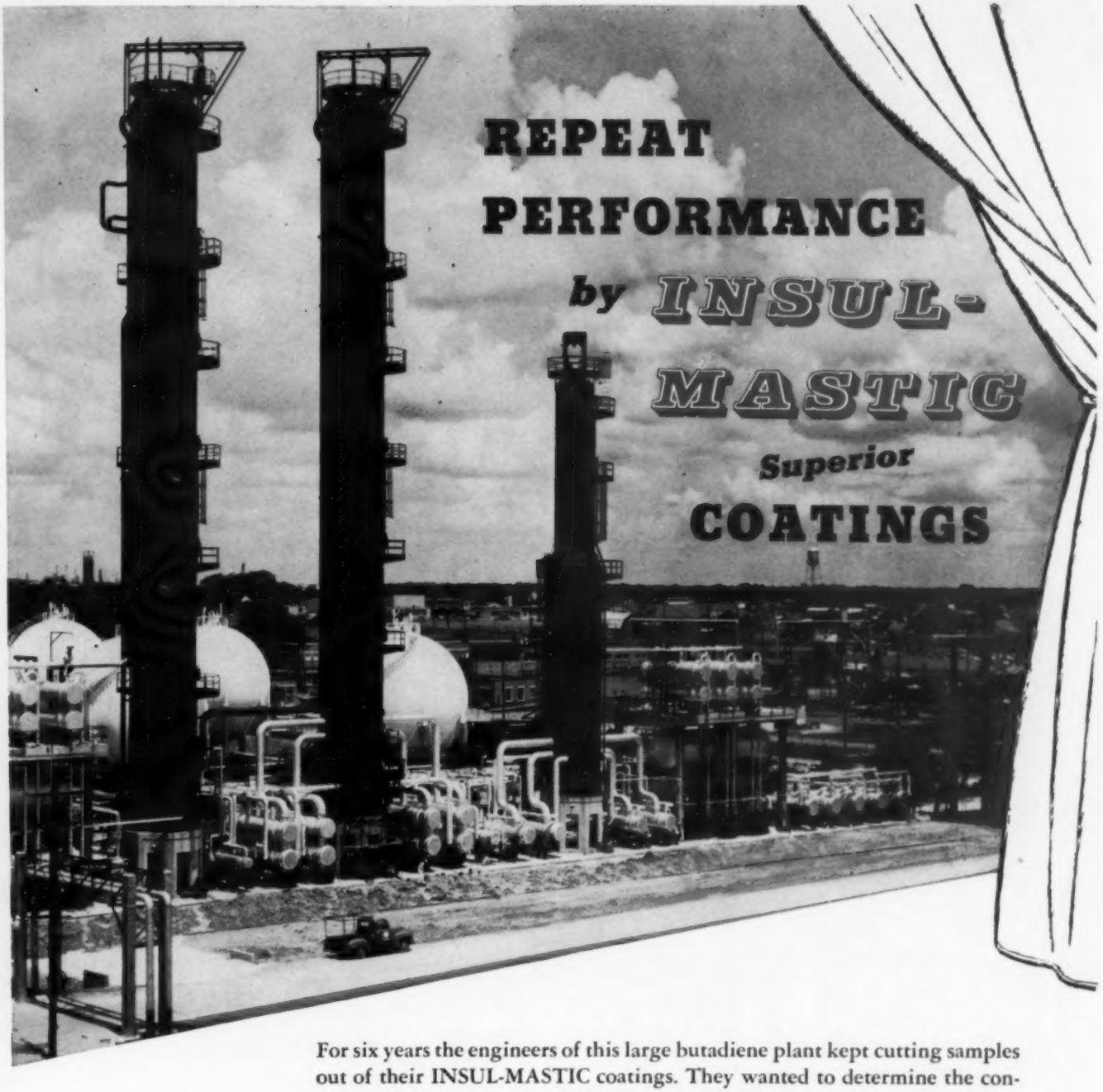

For six years the engineers of this large butadiene plant kept cutting samples out of their INSUL-MASTIC coatings. They wanted to determine the condition of the metal or insulation underneath. What they found was so satisfactory that INSUL-MASTIC was specified when the three new towers above were built. It takes excellent results to command a repeat performance from such critics.

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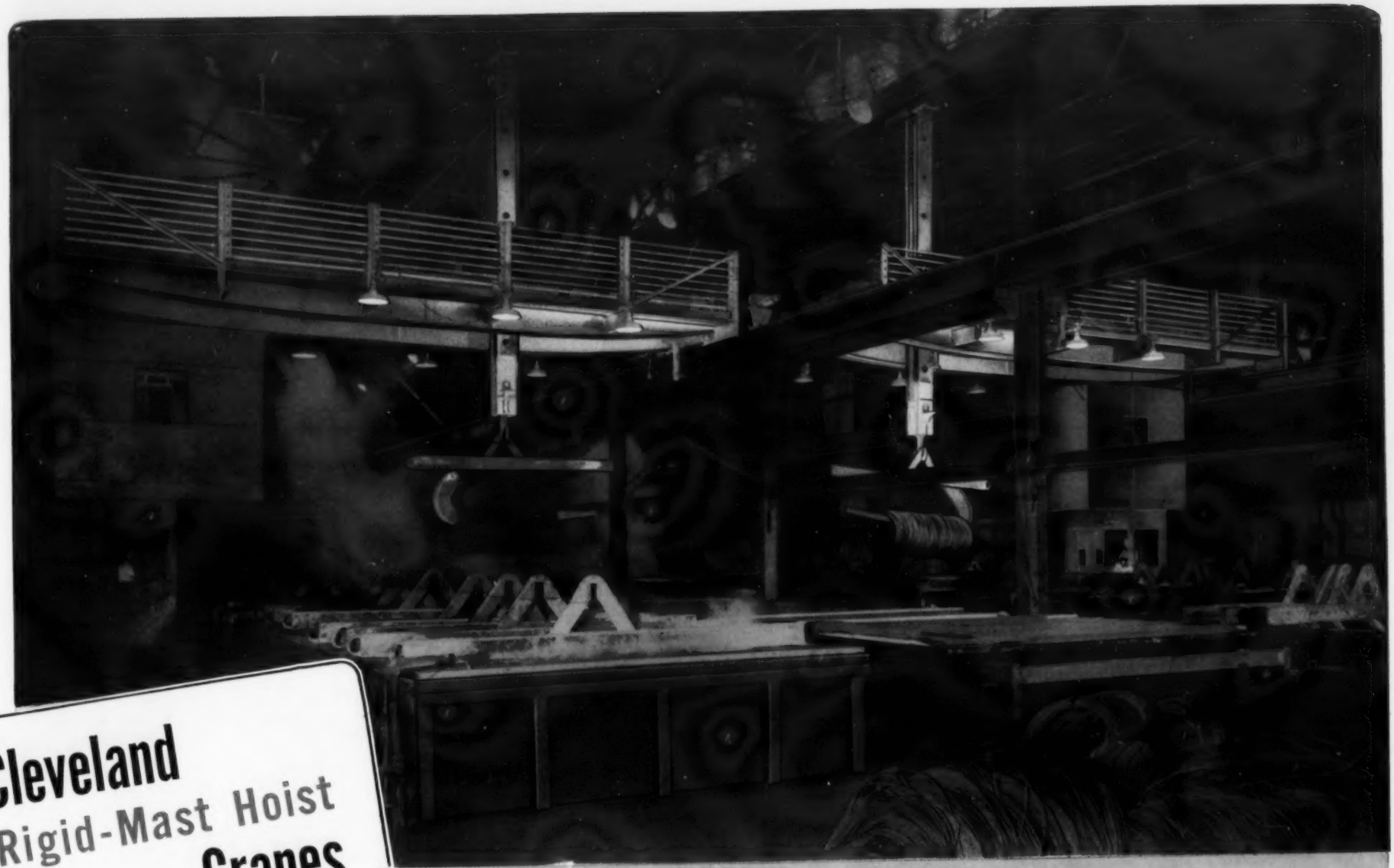

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B. F. FAIRLESS, chairman of United States Steel, told the Delaware Chamber of Commerce that prosperity requires peace, a stable currency, free competitive markets and incentive to enterprise. He said we now have the first three items and the fourth could be attained by government action designed to maintain an economic atmosphere that will encourage the flow of private investment and to enable business to operate at peak efficiency by scrapping obsolete equipment even if it is not worn out or fully depreciated.

▲

MR. Fairless looks for steel operations around 80 per cent of the new capacity for the first half of 1954. This would equal 86 per cent of the 1953 capacity. He believes that 1954 will be a good steel year even though under 1953.

▲

BEARING out the confidence expressed by business leaders in general are the announcements by General Motors of a $1,000,000,000 expansion program, and by the American Iron and Steel Institute of $775,000,000 to be spent by steel companies to improve plants. United States Steel alone plans to spend about $300,000,000 for that purpose.

▲

WITH demand off, stock piles high, price sagging and freight rates high, iron and steel scrap dealers are gloomy. But many of them comment that, even with the slide, it's still good business. And that, to judge from the wailing, is something that too many people are ignoring.

▲

AFTER wrestling with his income tax return, a friend of ours recently observed "If Patrick Henry had known what taxation *with* representation was like, he'd have kept his mouth shut."

▲

BLAST furnace production in the United States totaled 75,842,759 net tons in 1953, 13,700,000 tons above the 1952 figure, according to the American Iron and Steel Institute. This figure represents 95.5 per cent of the blast furnace capacity, and tops the previous record set in 1951 by about 4,600,000 tons.

A return post card of the type used to request product information or catalogs came into this office from California recently bearing this message: "Sirs: I found your magazine in a gutter yesterday and I would like to request a copy as I was very interested." While it was difficult for us to believe that a copy of the Iron and Steel Engineer would be found in a gutter (at least without a reader), it was even more amazing to discover that the card was from the April 1946 issue. At least we have longevity.

▲

FIGURES released by the American Iron and Steel Institute show steelmaking capacity for the various districts as follows:

	Net tons
Eastern	25,864,000
Pittsburgh-Youngstown	44,348,000
Cleveland-Detroit	12,792,000
Chicago	27,372,000
Southern	6,932,000
Western	7,022,000

▲

THE chap next door says that folks used to deny themselves luxuries to have money in the bank, but today they go without money to have luxuries.

▲

CLOSE on the heels of President Eisenhower's recommendation of a membership vote of union before striking (an arrangement which we firmly believe would eliminate more than half of our strikes) came the howls of denunciation from the labor heads. The prize remark was that it was much better to determine such things by the "democratic processes already set up within the union."

▲

A churchillian cynic says that never have so many Americans lived so well — or so far behind.

▲

BRITISH denationalization of its government owned steel industry is showing signs of bogging down. Difficulty has been encountered in selling stock — particularly, the common stock — of Lancashire Steel Corp., which was rated as one of the better buys. The sale of United Steel Corp. was oversubscribed but the stock has since fallen sharply. It is believed that the sale of many smaller, less attractive companies will require lower asking prices. A major deterrent is the threat of the Labor party to again nationalize the industry if it returns to power.

▲

IT'S fine to learn by experience, but preferably, other people's.

▲

PROBABLY every office is plagued with incoming letters bearing signatures that are completely undecipherable and, in many cases, without the name of the writer typed out. Further complications may be plain paper without a letterhead and with a highly illegible address. Such cases are particularly prevalent on foreign letters, but the domestic variety are bad enough. Let's all enlist in a campaign to promote the typing or printing of the name (and address, if no letterhead) on all letters. There'll surely be fewer unanswered letters.

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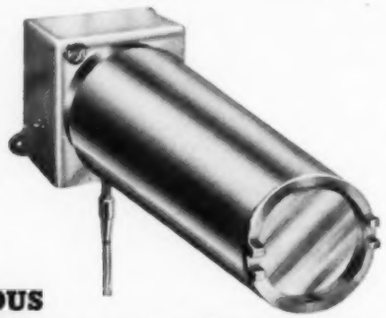

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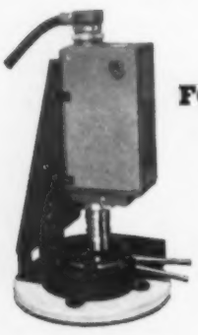

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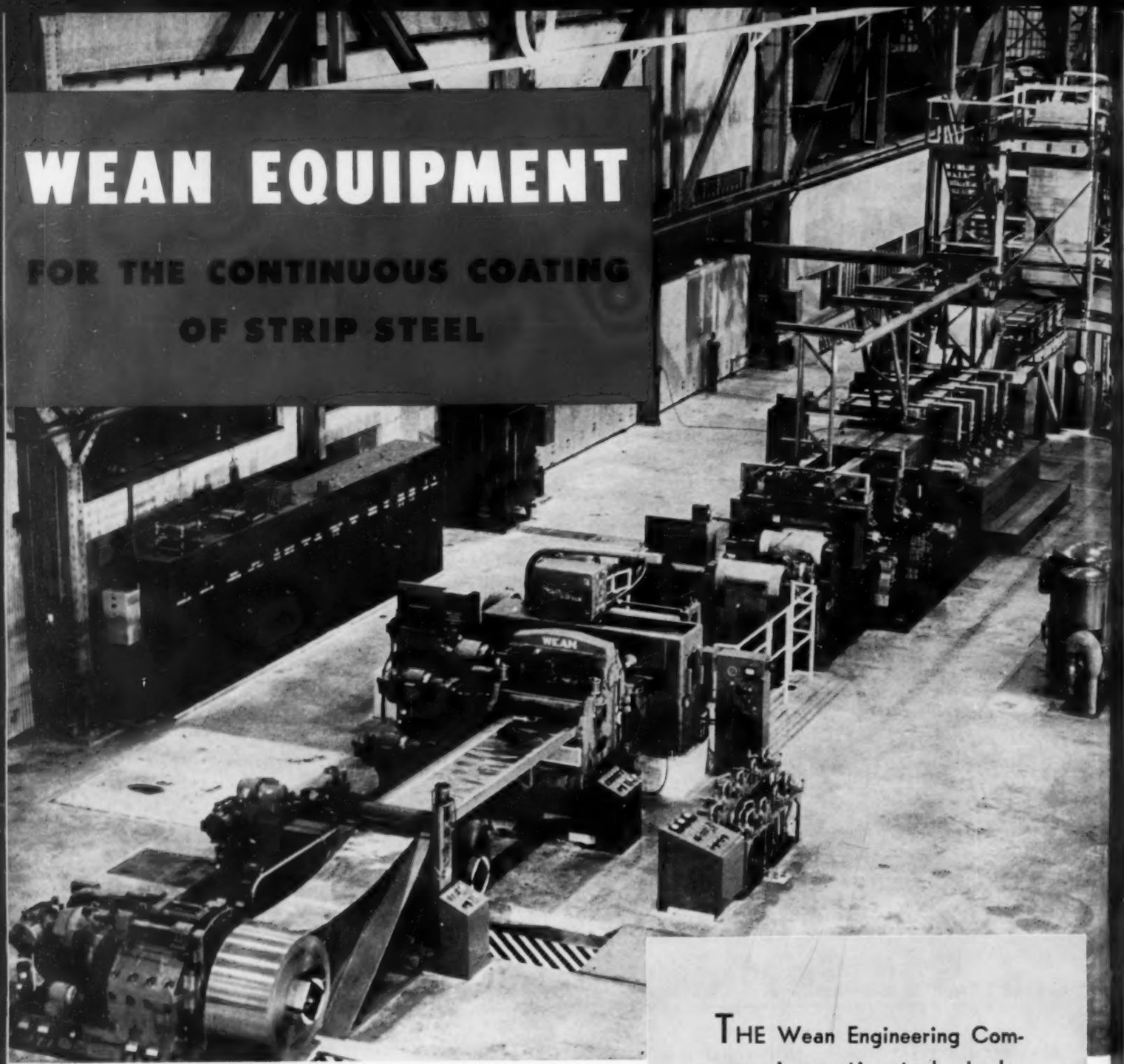

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Iron and Steel ENGINEER

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In This Issue

Patent Reviews — By Melvin Nord, Patent Attorney, Detroit, Mich. 23

Temperature Distribution in the Hearths of Blast Furnaces — By Professor V. Paschkis, Technical Director and Taghi Mirsepassi, Research Engineer, Heat and Mass Flow Analyzer Laboratory, Columbia University, New York, N. Y. 53

Impact of Technical Developments in Light Flat Rolling on the Consuming Industries — By William T. Hogan, S. J., Professor of Economics, Fordham University, New York, N. Y. 67

Heat Processing in Industry — Facts and Figures — By Frederick O. Hess, President, Selas Corp. of America, Philadelphia, Pa. 73

Kaiser Steel Corp.'s Fontana Plant — By T. J. Ess .....Following page 84

Growth Possibilities of Electric Furnace Carbon Steel — By Willard C. Wheeler, Management Consultant, New York, N. Y. 85

Developments in Communications — By W. M. Martin, Illinois Bell Telephone Co., Chicago, Ill. 95

Electrical Systems for Hot Strip Mills — By R. E. Marrs, Steel Mill Engineering, General Electric Co., Schenectady, N. Y. 99

Current AISE District Section Meeting Notices 108

Submarine to be First User of Atomic Power 110

Tunnel Furnace Built for Billet Heating 112

Proper Tools for Battery Maintenance and Repair 115

How Trailability Determines Tractor-Trailer Aisle Widths — By John J. Sichman, Assistant Chief Engineer, Mercury Manufacturing Co., Chicago, Ill. 120

Date-Line Diary 135

Industry News 149

Personnel News 167

Equipment News 187

Book Reviews 202

Index to Advertisers 207

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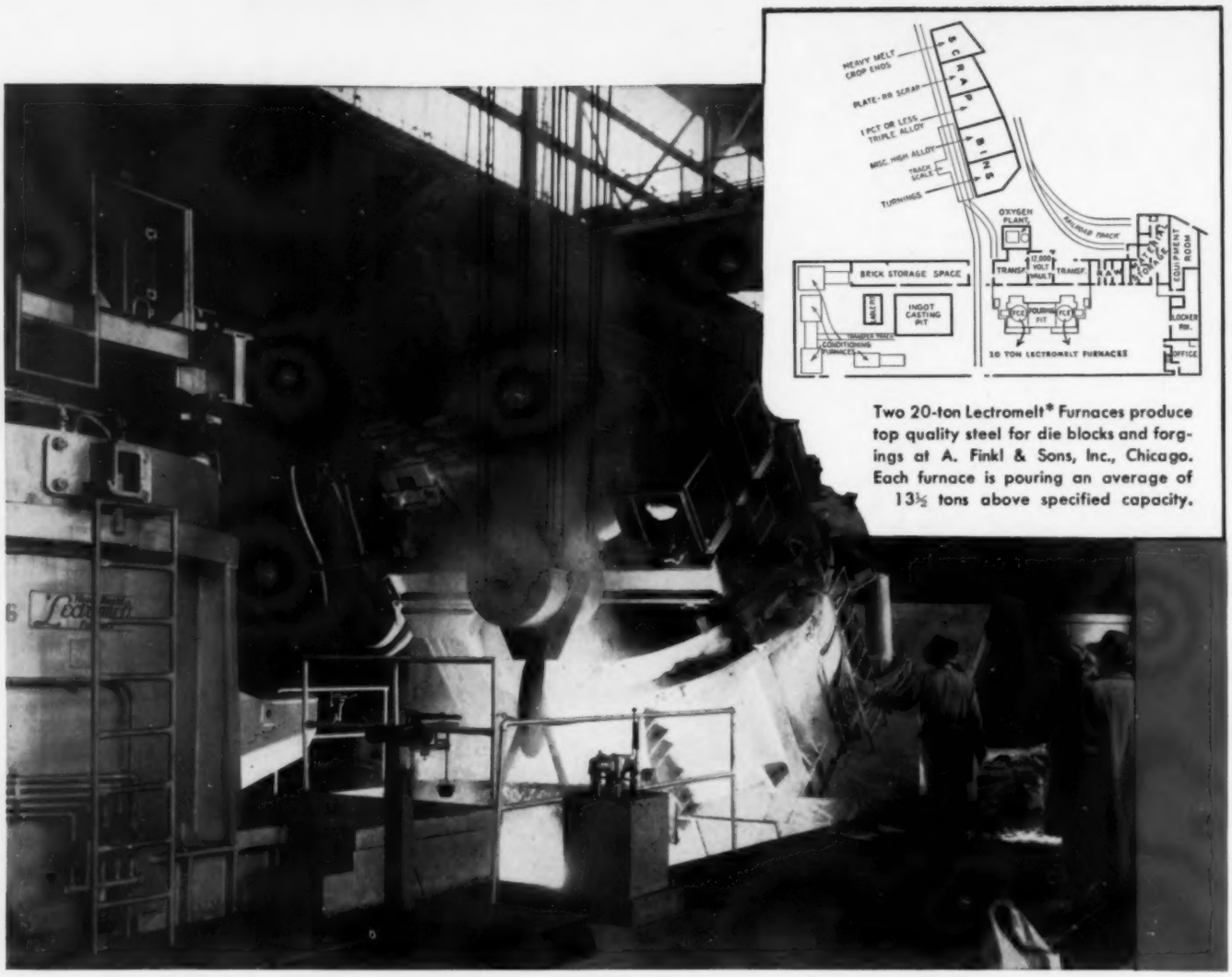
PLASTIC BINDING U. S. PATENT NO. 1970285 LICENCE NO. 120



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WHEN YOU MELT... MOORE RAPID Lectromelt

TEMPERATURE DISTRIBUTION IN THE HEARTHS OF BLAST FURNACES

By PROFESSOR V. PASCHKIS
Technical Director

and

TAGHI MIRSEPASSI
Research Engineer
Heat and Mass Flow Analyzer Laboratory
Columbia University
New York, N. Y.

. . . . as a result of this work sponsored by the AISE, new data is available which should help in blast furnace design . . . . the AISE solicits comments from operators which will indicate the advisability of setting up additional research work in this field, and which will help in planning the future work . . . .

▲ AT several meetings of the Association of Iron and Steel Engineers questions regarding the best lining for bottoms of blast furnaces have been raised. Each attempt to arrive at answers has led to the recognition that there is insufficient knowledge of the temperature distribution in the bottom.

Actual observations of temperature distribution in blast furnaces during operation are, to say the least, very difficult. With thermocouples, any troubles which may develop stop further observations because couples cannot be changed while the furnace is in operation.

For these reasons, the Association of Iron and Steel Engineers decided to study such temperature distribution by computation methods. The work was undertaken in a cooperative arrangement with Columbia University, with both the Association of Iron and Steel Engineers and Columbia sharing in the expenses.

The present paper represents a report of this work together with conclusions that can be drawn with recommendations for further work.

Before reading this report, it should be understood that it covers not measurements of actual temperature but results of computations. An electrical analogy method was used for the computations. This is briefly described in the appendix, but the technique need not be of concern to a reader who is not particularly interested in it.

As in any computations, the results are only as good as the assumptions on which the work was based. These assumptions and their practical significance are discussed in considerable detail in this paper. Space does not permit showing all data which have been obtained, but these data are available at Columbia University or at Headquarters of the Association of Iron and Steel Engineers for the inspection of any person who may be interested.

BASIC CONCEPT

It is known that as time passes, the inside contour of the furnace changes as the salamander is formed. Since the temperature distribution is of particular concern in connection with possible break-outs from the furnace, the temperature distribution at or towards the end of a furnace campaign is important. Since so little is known about size or formation of the salamander, the following concept was used.

Temperatures were determined assuming that temperatures no longer change with time and that the geometry of the lining and its thermal properties were as originally constructed. It was then assumed that the lining material above the liquidus line (which was assumed to be 2100 F) undergoes a change because it is

assumed that liquid iron penetrates only to this line. As will be explained in detail further in the paper, different assumptions were made regarding this change. As a result of this penetration, the 2100 F isotherm would move downward. This computational procedure is repeated several times, the second shift of the 2100 F isotherm being smaller than the first. Thus in consecutive steps, the 2100 F line was determined until no further change showed up in the computations. The main field of uncertainty in the assumptions concerns the region between the original contour of the furnace and the final position of the 2100 F line. For this region, the two main questions are the thermal conductivity of the mass occupying this space and a proper assumption for the temperature at the original contour.

To explain this situation, reference is made to Figure 1 which shows a schematic cross section of one furnace with several lines for the solidus (2100 F) drawn in. Each line connects all points which at any one time are

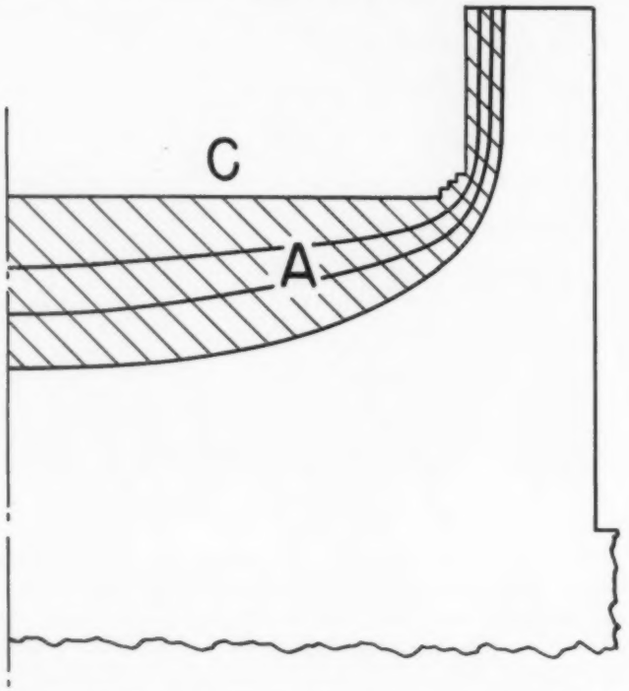


Figure 1 — The salamander space grows as the 2100 F isotherm drops lower and lower. Solid lines show 2100 F isotherm obtained at consecutive times.

at the same temperature; such lines are called "isotherms." As explained above, it must be assumed that, as the campaign of the furnace progresses, the 2100 F isotherm is shifted lower and lower. The shaded area *A* between the original contour *C* and the final 2100 F isotherm will be called the "salamander space." Assumptions regarding the material in the salamander space are significant.

DESIGNS

Three designs were investigated, design I had an all ceramic lining, design II a full carbon lining, whereas design III had a hearth floor of ceramic and hearth walls of carbon. See Figures 2, 5 and 7.

The inside diameters for the prototype furnaces were in all cases 28 ft. All other characteristic dimensions are given on the drawings which also include the temperature distribution.

MAIN ASSUMPTIONS

1. *Soil temperature* — The temperature distribution in the foundation under a blast furnace depends to some extent on the conditions of the soil underneath the furnace. Theoretically, the temperature under the furnace continues to rise slowly for the entire duration of a furnace campaign. However, practically, such a temperature rise stops after some time. In order to compute the temperature distribution in the critical areas, an assumption must be made that the temperature at a certain level below the hearth is constant. In the course of the computations, three values were introduced: 11, 20 and 29 ft of soil thickness below the concrete foundation. It was assumed that at this depth a constant temperature of 50 F prevails. Should a furnace be built in an area where there is a ground water level nearer to the surface than assumed in the experiments, then it would be reasonable to believe that the temperature at that point would be constant. It has been shown in the computations that the influence of the depth at which a constant soil temperature is assumed is not very critical with regard to the temperature distribution at and near the inner surface of the furnace.

2. *Conditions at the initial contour* — Most of the work was carried out assuming a constant temperature of 2700 F at the original inner contour. It was assumed that this temperature at this surface remains constant even if a salamander is formed underneath. It is recognized that this assumption is arbitrary, and the committee and the writers have spent considerable time discussing the merits and limitations of this assumption. It may be worthwhile to consider briefly possible assumptions regarding the temperature at the contour. Four cases seem conceivable:

a. After the salamander is formed, the temperature at the original contour increases but is still uniform.
b. After the salamander is formed, the temperature at the original contour decreases but is still uniform.
c. Formation of the salamander does not influence the temperature at the original contour.
d. The temperature at the contour changes in an irregular manner after the salamander is formed.

The assumption "a" cannot be reasonably defended in view of the fact that the major part of the thermal resistance to heat flow out of the furnace is in the lining and the thermal conductivity of the salamander is in all probability higher than that of the lining. The assumption "b" is conceivable but not very probable. It could be defended on the basis of the concept that the temperature at the level of the iron notch is constant and that, therefore, a change of the conductivity at lower levels influences the temperature distribution. In view of the small thermal resistance of the mass filling the zone between the iron notch and the original contour, such influence would be small.

Assumption "c" is the one discussed above and used in the greater part of the work. Assumption "d" is meaningful only if there is a certain reasoning underlying the assumed temperature distribution. (One such concept is discussed later in this paper.) In short, the

temperature distribution within the hearth of a blast furnace is not known. The assumption "c" lends itself readily to a computation procedure and, as will be seen, leads to results which appear to be useful.

A few computations were carried out assuming the rate of heat flow was constant, and using the same value for heat flow as occurs on the side walls. Such assumptions lead to quite unrealistic high inside temperatures.

Another assumption that was also suggested was to say that the lower surface of the salamander would always be at 2700 F. With such an assumption the lowering of the 2100 F isotherm continues indefinitely which is obviously not correct.

3. *Conductivity of the salamander space* — If iron penetrates into the joints between adjacent bricks or blocks in the salamander space, a dual influence results: first there may be a chemical reaction between iron and lining; and second, the temperature distribution in the hearth will change, caused by the variation in average thermal conductivity. It would be exceedingly difficult to account for each individual path of liquid iron, and, therefore, the concept was used that up to the point where a temperature of 2100 F prevails, penetration does exist with a resulting change in conductivity. Such a change is not easily computed. It is particularly difficult if relatively small bricks or blocks are used. Wherever a brick is completely surrounded by liquid iron, there is considerable chance that it would float to the surface. Cases are known where an entire brick or parts of bricks have been found enclosed in the salamander. But in view of the difficulties in establishing definite conditions, investigations were carried out for different average conductivities prevailing in the salamander space. The detailed assumptions will be discussed below in connection with the several computations. It must also be remembered that if there should be a flow of iron within the salamander, convection currents are set up in addition to the conduction which would change the apparent conductivity of the zone in question.

In thus dealing with the salamander space, only one aspect influencing the change of contour is considered: the gradual elimination of lining material by iron penetrating the joints and thus loosening the individual bricks or blocks.

However, mechanical erosion as well as chemical corrosion probably play an important part in this change of lining. These forces are beyond computational approach and are not considered here.

DETERMINATIONS

1. *Design I — All ceramic lining* — The salamander space was assumed to be filled alternatively with several materials of different conductivities lying between 1.33 and 9.2 Btu/ft, hr, F. The lower figure is the conductivity of the ceramic, the higher that of liquid iron. In way of comparison it may be stated that if a $\frac{3}{16}$-in. joint between bricks of 9 × 9 × 18-in. size were filled with liquid iron, the apparent conductivity of the system would be 1.62 in the 18-in. direction instead of 1.33 Btu/ft, hr, F, the conductivity of the original brick. The lower assumed value (1.33) would hold if no joints were washed out — a condition obviously representing an ideal which cannot be achieved. The salamander space may well be filled with a nondescript mass which has a conductivity in the range considered. Actual conductivities will probably approach the upper limit.

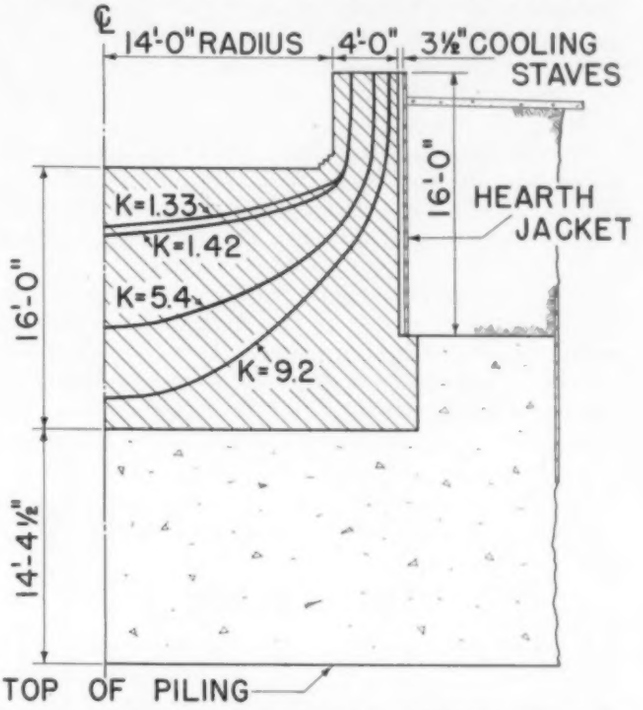


Figure 2 — Drawing shows location of 2100 F isotherm for the all ceramic-lined furnace.

For these different conductivities the 2100 F isotherms are shown in Figure 2 for Design I.

The effect of the conductivity of the material in the salamander space on the location of the 2100 F isotherm at certain key positions is shown in Figure 3. In this

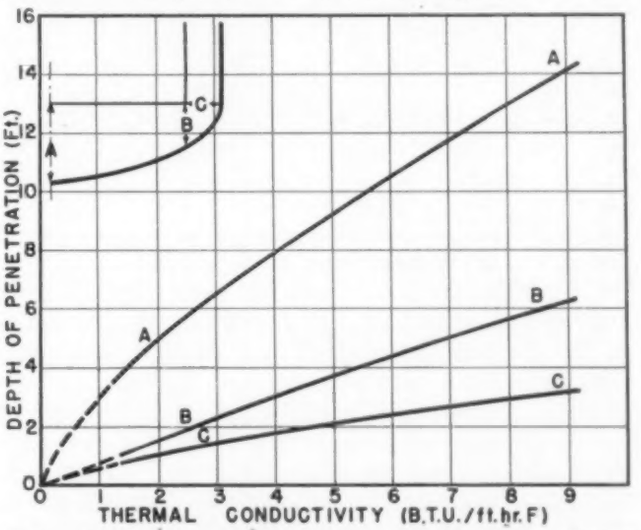


Figure 3 — Sketch shows depth of penetration plotted against thermal conductivity for Design I. Curves A, B, and C refer to the positions as indicated in the upper left corner of the diagram.

figure conductivity values of the salamander space are plotted on the horizontal axis and depths of penetration on the vertical axis. Three curves are shown: one for the center of the furnace, one at the inside diameter of the hearth, and one extending radially from that point to the outside.

It should be noted here that a relatively limited depth of penetration is achieved only as a result of cooling from the sides. Cooling is accomplished by water in the cooling staves and by air from the side and top of the foundation. If such cooling were eliminated completely, and if the original conductivity (1.33 Btu/ft, hr, F) would be maintained, then the vertical penetration at the center would be 26.1 ft, as against 3.6 ft with lateral cooling.

From this one may conclude that the depth of penetration and the best lining may vary greatly with the diameter of the furnace. One also must conclude that comparisons of depth of penetration between furnaces of different diameters are of limited value.

In a number of preliminary investigations it was found that the diameter of the concrete base and the assumption regarding the depth where the soil has a constant temperature of 50 F have but negligible influence on the position of the 2100 F isotherm.

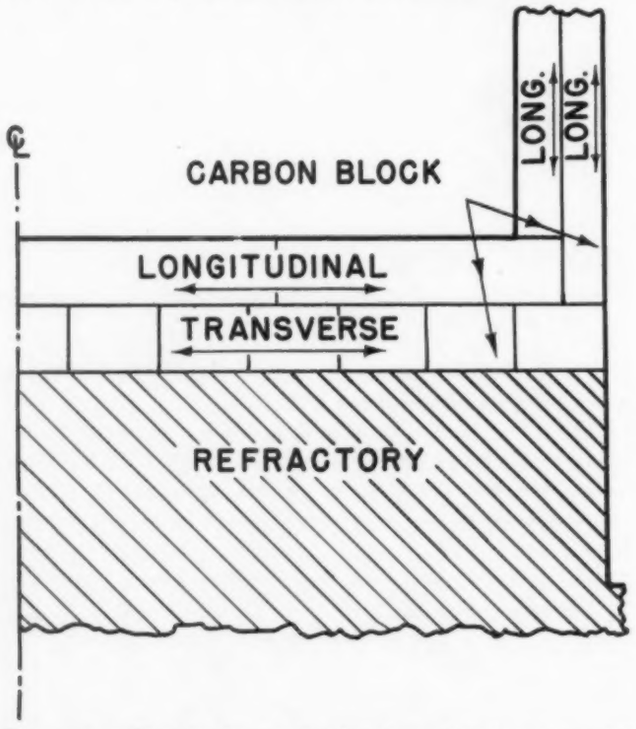


Figure 4 — Sketch shows distribution of lining material for the full carbon lining. (Design II).

2. *Design II — Full carbon lining* — Conductivities of the different carbon parts (bricks and blocks) vary according to the direction of heat flow through the material: "transverse" and "longitudinal" values of conductivities depend on the heat flow being transverse or parallel to the grain of the material. Values of conductivities are listed in the appendix. Figure 4 shows the location of the various materials used in the construction. The conductivities of the various carbons are close to that of liquid iron. Therefore for design II only two limiting conditions were examined: in one case the entire salamander space was assumed to be filled with the original material; in the other it was assumed to be filled with liquid iron.

The freezing lines (2100 F isotherm) for the two assumptions are shown in Figure 5.

3. *Design III — Refractory floor and carbon walls* — Location of the various materials is shown in Figure 6

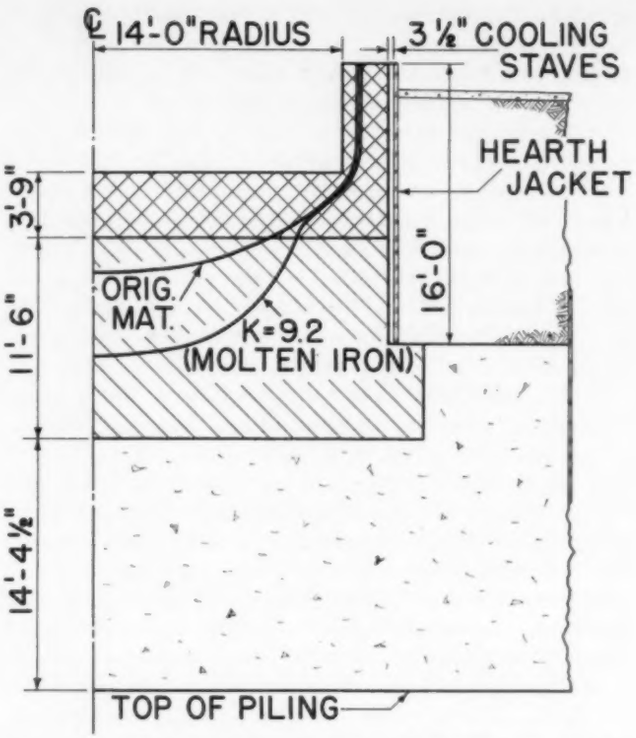


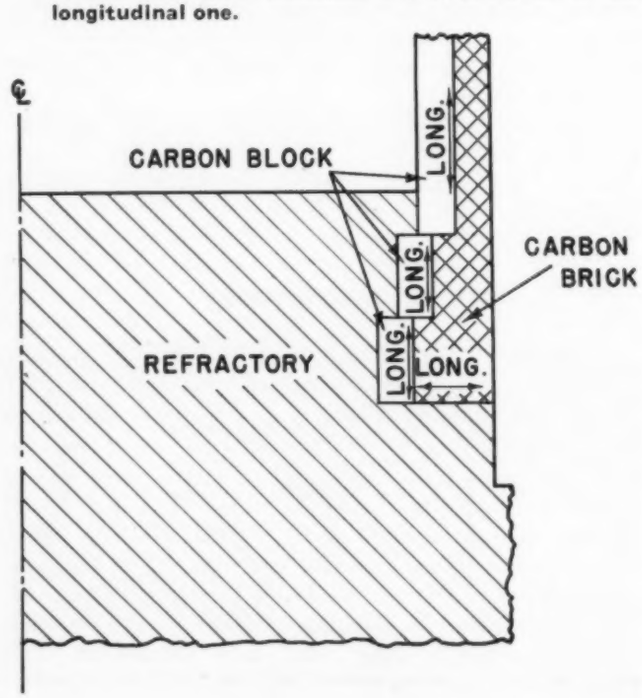
Figure 5 — Drawing shows location of 2100 F isotherm for the furnace with a full carbon lining.

and the freezing lines for the same two limiting conditions or design assumptions used in design II are shown in Figure 7.

DISCUSSION OF RESULTS

The practical steel man is primarily interested in break-outs rather than in vertical penetration.

Figure 6 — Sketch shows distribution of lining material for furnace with refractory floor and carbon hearth walls. Only the longitudinal direction of lining is shown. Transverse direction is perpendicular to the longitudinal one.



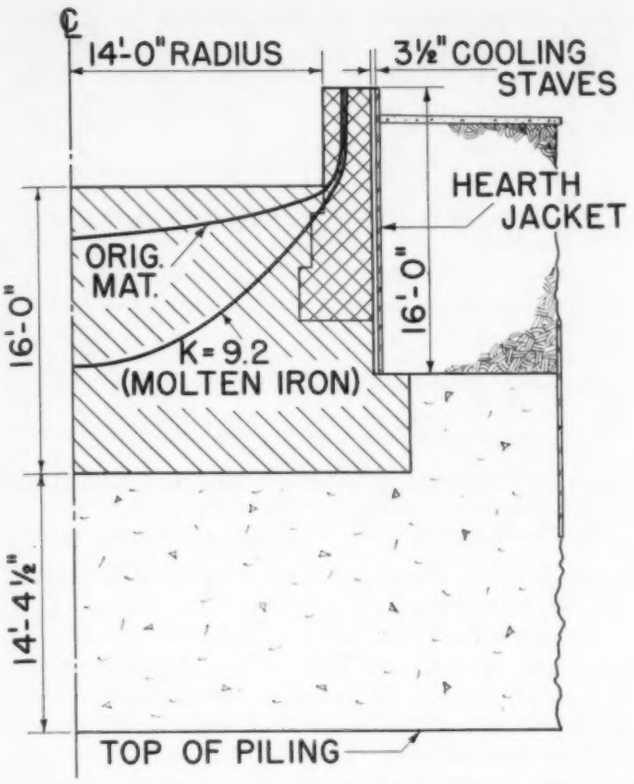


Figure 7 — Drawing shows location of 2100 F isotherm for a furnace with a ceramic hearth floor and carbon hearth walls. (Design III).

From this viewpoint, Figures 2, 5 and 7 are revealing. In the case of the all ceramic hearth (see also Figure 3) the position of the 2100 F isotherm, which is indicative of possible danger of a break-out, is greatly influenced by the conductivity of the material filling the salamander space. In the case of either of the two other hearth designs (Figures 5 and 7), that influence is much smaller.

In comparing the three designs, the "distance from the outside wall" seems somewhat more significant than the "penetration," because the distance represents a safety layer, which would have to be crossed by outflowing iron, before a break-out can occur.

Thus a thicker wall into which iron penetrates a certain distance is "safer" than a thinner wall in which the iron penetrates the same distance from the inner surface. In the first case, the "distance from the outside wall" is greater than in the case of the thin wall.

Refer, for example, to Figure 8 and Figure 9 in which the inside surface of the cooling staves is used as a reference point. Distances from this reference point are plotted horizontally. Vertical distances are referred to the contour of the original bottom as zero line. Points above and below this line are plotted vertically with distances above being positive and below negative.

For both figures each of the three lines shown holds for one of the three designs. Figure 8 holds for the case of the salamander space filled with material as originally installed. In practice, however, it has been found that these materials are eventually displaced by a "salamander." Therefore, the actual conditions are probably closer to those shown in Figure 9. This figure holds for

Figure 8 — Sketch shows computed distance of 2100 F isotherm from the outside surface of the shell on the assumption that the original conductivities in the salamander space is unchanged.

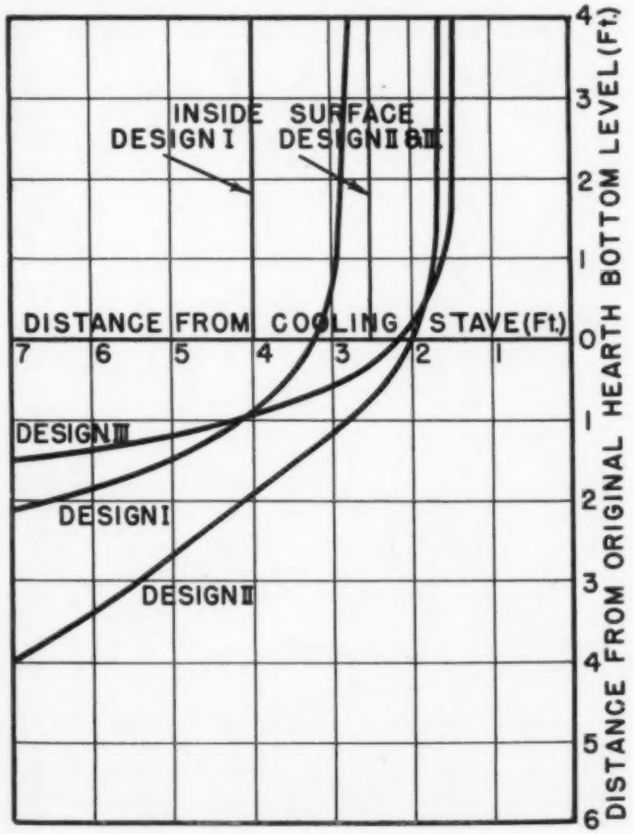
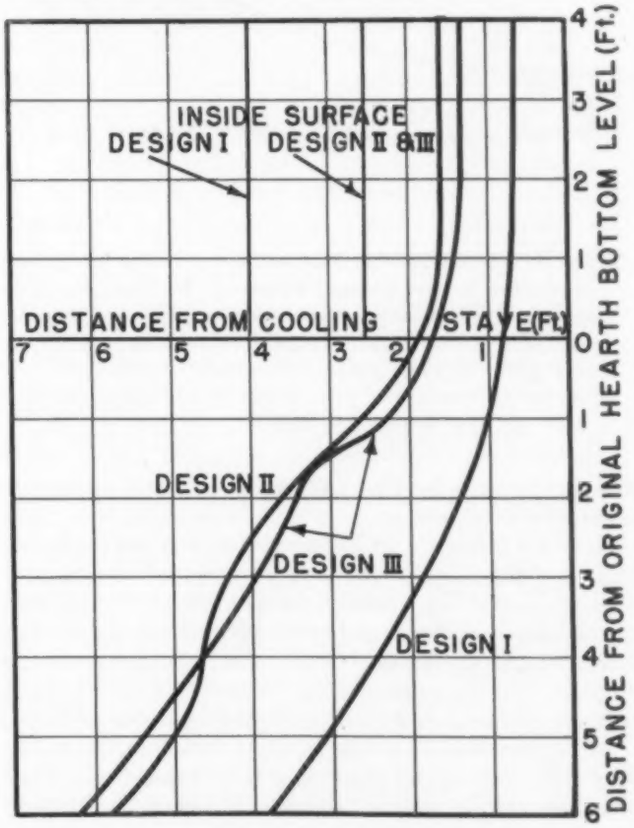

INSIDE SURFACE
DESIGN I
DESIGN II & III
DISTANCE FROM COOLING STAVE (Ft.)
7 6 5 4 3 2 1 0 1 2 3 4 5 6
DESIGN III
DESIGN I
DESIGN II
DISTANCE FROM ORIGINAL HEARTH BOTTOM LEVEL (Ft.)
4 3 2 1 0 1 2 3 4 5 6

Figure 9 — Sketch shows distance of 2100 F isotherm from the outside surface of the shell on the assumption that the conductivity of the salamander space, k = 9.2 Btu/ft/hr/F, or same value as liquid iron.


INSIDE SURFACE
DESIGN I
DESIGN II & III
DISTANCE FROM COOLING STAVE (Ft.)
7 6 5 4 3 2 1 0 1 2 3 4 5 6
DESIGN II
DESIGN III
DESIGN I
DISTANCE FROM ORIGINAL HEARTH BOTTOM LEVEL (Ft.)
4 3 2 1 0 1 2 3 4 5 6

the case of the salamander space completely filled with molten iron. Notwithstanding the fact that the side wall thickness of the all ceramic lining (design I) was thicker than that of either design II or III, the penetration is so large that a smaller distance from the cooling staves remains for design I than for either of the two other designs.

A comparison of designs II and III shows that design II (all carbon) is superior to both designs I and III, down to a depth of four ft below the zero line (Figure 9). At greater distances from the zero line, design III seems to be superior. The crossing of the lines for designs II and III can probably be explained by the greater depth of carbon in design III.

FUTURE WORK

1. There is strong reason to believe that depth of penetration and distance of the 2100 F isotherm from the outside wall depend on the diameter of the furnace. Hence a study of the influence of furnace size and depth of penetration should be made.

2. It is probable that the length of the cooling staves

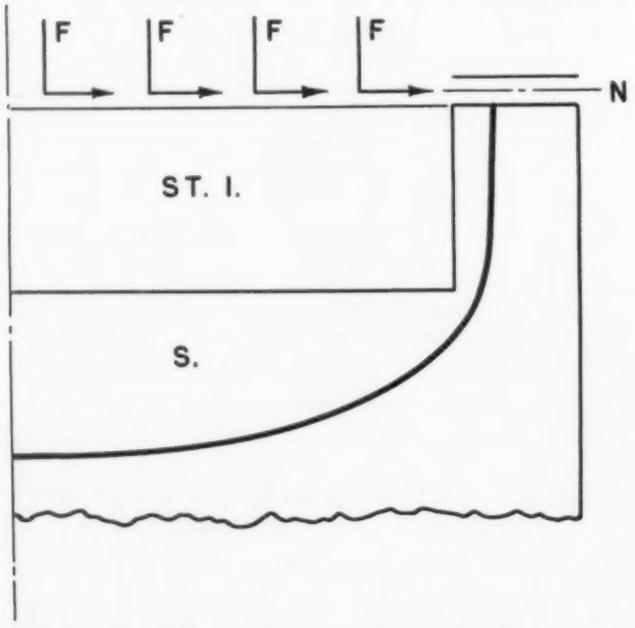


Figure 10 — Sketch shows one concept of temperature distribution in the furnace bottom. "N" indicates iron notch, ST I indicates stagnant iron filling the interval between the iron notch and the original contour of the furnace, "S" indicates salamander space and "F" indicates direction of flow of iron at equal rate per unit area in the downward direction.

also influences the penetration of the iron. This too should be investigated.

3. With reference to Figure 9, it seems quite possible that a design combining the features of the present designs II and III would yield still better results; such a combined design would probably extend the carbon lining to greater depth, but eliminate the carbon lining as unnecessarily expensive in the center portions of the furnace. Several such designs might be investigated.

4. In the text it was mentioned that there was considerable uncertainty regarding the assumption of the conditions at the original inside contour of the furnace.

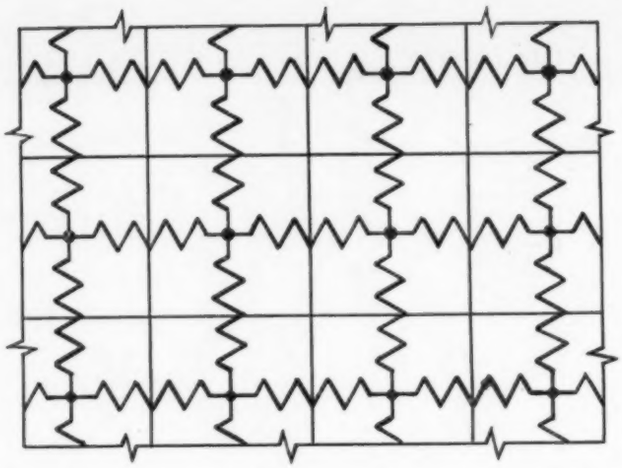
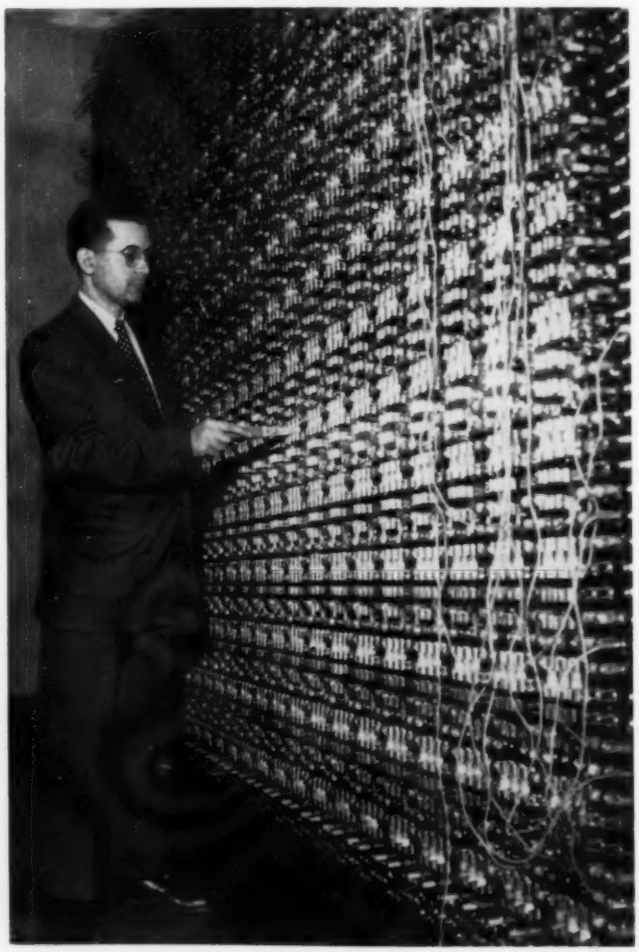


Figure 11 — Elements of electrical network represent the lining of the furnace.

One assumption would warrant additional investigation and can be explained with reference to Figure 10. It would be assumed that any iron below the level of the iron notch is stagnant. This includes the salamander when it is formed. Over the surface of the stagnant pool of iron, the iron would flow radially at a constant rate. It is assumed that, at least in the lower part of the shaft, the downward flow of iron is at a uniform and constant rate (lb/sq ft, hr = constant). If this downward flow of iron is at a constant temperature at a level just

Figure 12 — The electrical analogy method requires extensive and complicated equipment for its solution.



above the iron notch, then the different parts of the iron will lose temperature at different rates. It is possible to compute the temperature distribution in the lining based on this concept.

ACKNOWLEDGEMENTS

The authors are indebted to the committee which directed this work and comprised the following men: J. C. Foster, chairman, W. T. Clark, W. H. Collison, W. S. Debenham, J. E. Eberhardt, A. E. Fitzgerald, Henry S. Hall, Carl Hogberg, I. E. Madsen, and V. J. Nolan.

Particular thanks must be expressed to Dr. Eberhardt who served as liaison man between the committee and the laboratory. No important decision regarding the conduction of the experiments was made without consultation with Dr. Eberhardt. His cooperation and continued enthusiastic support contributed much to the success of this work.

APPENDIX

1. *Description of technique* — The mathematical laws governing the flow of heat in solids and those governing the flow of electricity in electric conductors are identical. Hence it is possible to set up an electric system to represent a certain body, carry out electrical measurements, and then translate the results into heat terms.

Since "steady state" only was considered, the blast furnace hearth can be represented by a network of electric resistors. Each physical part (or lump) of the lining is covered by two resistors, as shown in Figure 11, one resistor each for radial and axial heat flow. In this case, the network contained more than 1100 resistors.

Temperatures are represented by voltages. The temperature in the soil (50 F) assumed to be constant is used as zero-reference. The temperature of the liquid iron (2700 F) is the maximum voltage (265 v), so that 10F are represented by 1 volt.

Voltage measurements in the network then disclose the temperature pattern.

2. *Properties, assumed* —

Conductivities:		
Ceramic	1.33	Btu/ft, hr, F
Carbon brick, longitudinal	4.125	Btu/ft, hr, F
Carbon brick, transverse	2.75	Btu/ft, hr, F
Carbon block, longitudinal	9.45	Btu/ft, hr, F
Carbon block, transverse	7.175	Btu/ft, hr, F
Boundary conductances:		
Surface to air	0.8	Btu/sq ft, hr, F
Side wall to cooling staves:		
Design I	2.26	Btu/sq ft, hr, F
Design II	6.06	Btu/sq ft, hr, F
Design III	5.17	Btu/sq ft, hr, F

DISCUSSION

PRESENTED BY

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I. P. BAHME, Field Engineer, Pittsburgh Pipe Cleaner Co., Pittsburgh, Pa.

C. G. HOGBERG, Assistant Chairman, Operating Committees, United States Steel Corp., Pittsburgh, Pa.

V. J. NOLAN, Manager Industrial Sales, Promotion and Development, National Carbon Div., Union Carbide and Carbon Corp., New York, N. Y.

James C. Foster: Several years ago steel plant operators requested the Association of Iron and Steel Engineers to sponsor a research project to develop what sort of temperatures were actually present in the blast furnace. Very little actual data was available on this subject, and the problem is so difficult that computation methods are either too impractical or too tedious to get any general results. It was felt that such data is essential in evaluating different types of blast furnace linings, and in predicting what particular results would be obtained with suggested changes in furnace design.

Columbia University is one of the very few places in this country where computing equipment is available which can mechanically do this type of work. The Board of Directors of the AISE authorized a research program be set up at Columbia under the guidance of the blast furnace thermal distribution committee. Just a few of these results were presented by Dr. Paschkis, the man who developed the equipment and built the laboratory at Columbia.

There has been some discussion that this work may not be acceptable because it is theoretical. The committee is firmly convinced that the answers which have been obtained are correct. However, these answers are only as good as the assumptions which have been used in the thermal distribution studies. There have been some differences in opinion in these assumptions, and if you feel that these are correct, you may also assume that the answers are correct.

However, the committee is very much interested in obtaining from those here and by letter from operators and engineers of the steel industry any information which they may have which will check some of the assumptions which were set up for this work. We are also very much interested in hearing comments on any phase of the work.

We are trying to decide what is to be our future program. However, before the AISE will authorize the

extension of the sums which will be required to finish this work, they want to be sure that the program is on the right track that you blast furnace men desire, and also that you men feel that the data obtained is correct, worthwhile, and of value to you.

I might also say that this is only one of a number of projects carried out by the Association of Iron and Steel Engineers in the field of research and standardization, and is an attempt to provide data which will be of value to the steel plant engineers, and to engineers in general.

C. M. Horan: I appreciate the fact that the paper is highly theoretical, but am of the opinion that much more work should be done before it can be applied in a practical manner. In Figure 5 (full carbon bottom), the carbon wall shows considerably shorter than the carbon wall in Figure 7 (carbon wall and ceramic bottom) if this is true, then how much effect did this have on temperature distribution?

The Youngstown blast furnaces are furnished cooling water from the Mahoning River. From winter to summer the temperature of this water varies from about 60 to 120 F. What effect then does the temperature of the cooling water in the hearth staves have on the lining? Would this condition allow for deeper iron penetration into hearth walls and perhaps result in a hearth breakout? This also brings up the question — Do conventional hearth cooling staves give adequate hearth cooling?

In conclusion, I would like to say, that regardless of the type of material used in the bottom of blast furnace linings, it is not a bit better than the manner in which it is installed.

Professor V. Paschkis: Mr. Horan refers probably to the fact that in the case of Figure 7 the carbon side wall extends over a greater height than in the case of Figure 5. This, of course, represents a different design; it cannot be stated offhand how much this contributes to the differences in temperature distribution. This should be explored by additional work, as suggested in the paper.

The influence of the cooling water temperature could be easily ascertained by computation; a simple throw of a switch and subsequent voltage readings is all that would be required. Off-hand, I would guess that a change from 60 to 120 F would not produce large changes.

The last question, how adequate hearth cooling staves are, is not easily answered. It depends first of all upon the definition of adequacy. Then water velocity, deposit of lime, possibly also the existence of a gap between stave and lining are important.

Certainly the emphasis on proper installation is justified.

G. D. Elliot: (By letter) Mr. Mackenzie of our research and Development department and myself have read the paper and we think that it reports a very nice piece of laboratory work; we only wish they had taken the work a stage further and, in the various designs, considered the influence of undercooling.

Once hearth breakouts cease to be the major headache, and I have confidence that this day is not far ahead, then the prevention of salamanders becomes increasingly important.

It appears to us that the analogue method could be usefully employed to determine the location and extent of under cooling necessary to freeze in place the top block of the hearth floor. There is, of course, one important omission in work of this kind, and that is the influence of chemical changes on the refractories during service. We know that changes take place in ceramic refractories, and we have very good reason for believing that graphitization of amorphous carbon takes place in service. What will be the effects of these changes on the results reported?

We are inclined to disagree somewhat with the authors' conclusions on page 9 that a thicker wall is safer than a thinner wall; the thicker wall will wear back until the effect of cooling is felt.

We feel that the work indicates that, in general, carbon walls can, with safety, be thinner than ceramic walls. From the isotherms in Figure 2 and Figure 5, it appears that the remaining thickness of carbon is greater than that of fireclay brick. This would be reassuring if it were not for our anxiety about the influence of chemical changes as graphitization we mentioned earlier.

Professor V. Paschkis: In answer to Mr. Elliott, his suggestion to study the undercooling, is of course quite possible and might be included in further work. He apparently misunderstood the following paragraph in our paper. "In comparing the three designs, the distance from the outside wall seems somewhat more significant than the penetration, because the distance represents a safety measure which would have to be allowed for out flowing iron before a break-out can occur."

Now, here comes the sentence which he objects to: "Thus the thicker wall into which iron penetrates a certain distance is safer than a thinner wall in which iron penetrates the same distance from an inner surface."

This last qualification was apparently overlooked. Obviously without this qualification, one cannot compare the safety of thick and thin walls. We do not contend that the thicker wall itself is safer than a thin wall.

W. H. Collison: Some observations of the salamander removed from Great Lakes "B" furnaces assume more significance in the light of Dr. Paschkis' paper. "B" furnace, of 27 ft 3 in. hearth diameter, was blown in September 5, 1947 with a carbon bottom of the general type of design II of the paper. It was blown out April 1, 1953 because of a stock line failure. In the campaign of five and one-half years it had produced 2,495,265 tons of iron.

The bottom consisted of two courses of 22½-in. carbon block with 2-in. vertical joints filled with carbon ramming mix, below which were standard hearth and bosh quality block to a total depth of 13 ft 6 in. The side wall was made up of two rings of 15-in. carbon block, separated by a 2-in. joint filled with ramming mix and backed with a 3-in. space filled with tarred breeze, for a total wall thickness of 35 in. Hearth staves were 14 ft long, terminating 33 in. below the bottom of the carbon block.

No attempt was made to drain the salamander. When the furnace was cleaned out down to the salamander it was found that the salamander top was only about 3 in. below the level of the original hearth bottom. As

the bosh lining was removed, the carbon blocks of the hearth wall appeared to be in good condition and without displacement. Before proceeding with a relining of bosh and inwall only, lancing to probe the depth of the salamander was done. At depths of five feet, well below the carbon block level, indications of iron were still noted. Cutting out of the side block preparatory to blasting the salamander was started.

We were startled as this work progressed to find at lower levels an irregular ring of iron between the two rings of carbon blocks ranging from 2 to 8 in. in thickness, the greater thickness being at lower levels. Vertical strata indicated intermittent building of this ring, whose face was about 18 in. from the cooling staves. This may be compared with Figure 9 of the paper, showing distance from the cooling stave of the 2100 F isotherm.

As chunks of the salamander were blasted loose and removed, two distinct layers were noticed. The top layer, 70 in. thick, had a stony fracture and a gray appearance. Analysis of this material gave the following percentages:

Iron	44.60
Silica	12.58
Phosphorus	0.108
Manganese	0.64
Alumina	2.78
Lime	10.83
Magnesia	0.92
Sulphur	0.430
Carbon	26.55
Titania	0.10

The bottom layer, about 18 in. thick, was coarsely crystalline, with long needle like crystals coated with carbon not resembling the usual grey grainy fracture of iron. On analysis it proved to be very good basic iron:

	Per cent
Iron	92.40
Silicon	1.29
Phosphorus	0.220
Manganese	1.01
Alumina	0.19
Lime	Trace
Sulphur	0.015
Carbon	4.18

Total weight of these materials was 469 tons.

Below the salamander, iron penetration into joints to a depth of about 2 ft was noted. The total depth of penetration was 9 ft 7 in. of which 7 ft 7 in. was washed out. This may be compared to Figure 5 of the paper shown, 2100 F isotherm for design II, if allowance is made for the 27 ft 3 in. hearth.

However, when discussing the salamander space, its contents and rate of heat conductivity, the above data are apparently confusing. A possible explanation is that the bottom was washed out to the 7 ft 7 in. level noted and was probably filled with molten iron. This was frozen in one of the two extended banks experienced, one of 43 days in 1949, and the other of 56 days in 1952. The layer of material, which seems to be a mixture of iron, carbon and slag, built into a serviceable bottom as the cold bottom slowly warmed up, perhaps raising the 2100 F isotherm and permitting the crystal growth of the bottom layer of iron.

Professor V. Paschkis: The comments of Mr. Collison were very welcome. They tend to show that the assumption of iron in the "salamander space" may be correct.

Leonard Tofft: In my opinion, the authors of this paper have done an excellent job in exploring, in the laboratory, this quite unknown section of the blast furnace. Surely, work of this type will ultimately help guide us in proper, safe, and economical design of furnace hearths. No doubt, the electrical analogy method as used in this paper is essentially correct under static conditions. However, a few questions have arisen, which could be cleared up with a more thorough inspection of the basic data — time did not permit this.

This 2100 F isotherm lines indicate quite different positions in the designs studied, pointing towards the desirability of carbon hearth wall construction. Figure 9 summarizes the work, clearly showing this line much closer to the stave in the ceramic construction, even though the original wall was thicker. Also, the resultant probable salamander line is closer to the stave, and deeper. All this is reasonable, and possibly quite close to what happens in a blast furnace, if based on static conditions and heat conductivity alone. As the authors point out "blast furnace break-outs often occur at levels just below the original contour of the hearth, and may be attributed to the lack of freezing of the iron as it penetrates between joints of the lining". Why does the iron not freeze? Is it because of relatively low heat conductivity of the brick material, or are there other contributing factors? There are others and the authors so recognize them, when they state that "mechanical erosion as well as chemical corrosion probably play an important part in this change of lining". However, these forces are so severe, particularly in the tap hole region, that the 2100 F isotherm lines are undoubtedly shifted, with time, continually closer to the cooling stave unless there is another counteracting force to stop it. This would be the ability of the cooling stave to extract enough heat from the lining to keep the freezing line of the iron at a safe distance from the stave. This, we feel, contributes much to preventing side wall break-outs. Our experience at the Geneva works may illustrate this point.

As many of you well know, we have had more than our share of hearth break-outs at this plant. If it has done nothing else, it has at least given us valuable experience in analyzing "what has happened" and "why". All of the breakouts have occurred just below the tap hole, and have broken through, at one time or another, standard quality, cone 18, and carbon brick construction. Evidence has been found, at times, of excessive chemical attack in this region by complex alkali-cyanide compounds existing in the hearth zone. The extent of the break-outs and brick remaining in the side walls has, in general, been the same. With these facts in mind, a theory of brick destruction has been evolved, which is offered for what it is worth, and for your consideration:

Chemical disintegration, mechanical erosion, and effect of tap hole clay on refractories in the tap hole region, are quite severe, and vary, undoubtedly, with

the raw materials themselves and the type of furnace operation. Regardless of the rate of brick removal by these forces, and the subsequent shifting of the freezing line towards the stave, some method must be employed to stop this at a safe distance. High heat conductivity of the brick itself is not enough, as evidenced in this plant. With the present design cast iron staves, the heat extraction ability is not high enough to stop this penetration. The cooling effect from the stave establishes some point in the wall where the iron will freeze; it may be too close to the stave for comfort. If a more efficient type of cooling member can be designed for only this critical tap hole region, then it may be possible to prevent these break-outs. With this in mind, a small test furnace has been erected to properly evaluate stave designs. Using the present cast iron type as a base, tests will be run on other types of designs and materials to find the most efficient as far as heat extraction is concerned. This then, combined with the most highly conductive brick side wall construction possible, might provide the answer. Along with this, the best possible brick workmanship, coupled with intimate contact between the brick and the stave, should be insisted upon. Our testing program is aimed at arriving at these answers.

All of this is offered to supplement the fine work of the authors. It may also, we hope, suggest new avenues of research in any possible future work on this very important topic.

Professor V. Paschkis: The shifting of the 2100 F isotherm line which Mr. Tofft observed is probably caused by a combined effect of corrosion, erosion and temperature. As will be noted from our paper, we have taken into account the shifting of the line, so that our paper does not deal with what Mr. Tofft calls "static conditions"; the only difference seems to be that, in our case, the shift occurred under the influence of temperature alone. In any instance, the heat loss from the surface governs the position of the 2100 F isotherm. If it appears that the penetration near the notch is particularly important, tests not involving the entire furnace seem a good idea. However, care must be taken to truly represent the conditions of the furnace.

Mr. Tofft speaks of the cooling effect of staves. This cooling effect for a given thickness of the lining depends on three thermal resistances:

1. One from the outside surface of the lining to the cooling stave.
2. One through the thickness of the stave.
3. One from the other surface of the stave to the cooling water.

The second one is very small compared with the first and third; any changes made there would be of small influence. The third one can, with some skill and knowledge be controlled, and can thus be made to be the same in a small scale experiment and a furnace. But the first one may be materially different in the small experimental set-up of which Mr. Tofft speaks and in a furnace. And thus caution is advisable lest wrong conclusions be drawn from such tests. Cooling is a heat transfer phenomenon, and unless experiments are judiciously planned, results can be truly misleading.

John F. Elliott: The authors have done very well in bringing out some very important facts covering the integrity of a blast furnace bottom. It is encouraging to note that these men who are treating this problem from a rather theoretical standpoint are well aware of the very limited interpretations that can be placed on their results. These limitations arise because of the assumptions that are necessary to make the calculations possible.

It appears from the diagrams that the main heat sink is the cylindrical arrangement of cooling staves which extends both above and below the original hearth level. The authors indicate that heat flow to the surrounding ground is of little consequence. With the original hearth contour assumed to be maintained at 2700 F, the heat flow to the cooling staves is determined by the thermal resistance in between this contour and the staves. Locating the steady-state 2100 F contour is a complex problem because it depends on how far the iron penetrates, but also the penetration of the iron depends on the location of the isotherm. In addition, the geometry of the system is complex, hence the need for an analogue computer technique for the problem.

A person considering the problem of hearth break-outs must recognize that the general safety of a lining will depend upon its ability to keep the iron from penetrating it. This is of course one of the main reasons for cooling staves. A liquid-tight container for a liquid like iron is possible because the iron can penetrate only so far before it freezes. If one follows the diagrams shown here then, no hearth break-out should ever occur. However, in designing a hearth, one must recognize that seemingly small factors may be of as great importance as the general principle outlined. For example, points of weakness in the refractory which for some reason suddenly became accessible to the liquid iron could result in break-outs. The reason for this is that the sudden intrusion of hot iron could easily nullify the local chilling action of the cooling staves, and by its own heat gain exit from the furnace.

The authors have commented on the very significant fact that the character of the refractory-iron combination within the limit of penetration is of great importance. It must be recognized that their assumption to the effect that nothing remains but the liquid iron is conservative. For a stagnant system, it results in the maximum penetration of the 2100 F isotherm.

In the discussion of future work, it is noted that circulation of the liquid iron must be considered. It is felt, however, that the problem is much more complex than indicated. There is a strong possibility that convection currents exist in the main body of the salamander. The iron on the outside could be cooled, and because of its greater density it would flow downward to collect on the bottom of the salamander bowl. This would displace metal in the central area upward into the warmer Zones where it would be heated. The warmer metal would drift to the outside zone where it would be cooled to complete the cycle. The main effect of such a circulation would be to push outward and downward the limit of penetration. It is noteworthy that circulation of this type is thought to exist in a ladle of steel. See M. A. Hadfield and A. J. Donald, *Journal*, West of Scotland Iron and Steel Institute. 59, 63 (1951-1952).

Another possible source of circulation could arise if gases were liberated as a result of some chemical

reaction, perhaps the formation of CO from the reaction of carbon in the iron with one of the constituents of the refractory. The circulation of hot iron to and away from this focus of action could cause a hot spot and a possible point of failure.

Another source of motion in the liquid may be the everchanging amount of penetration into the bath of the mass of coke above it. There are reasons to believe that the penetration of this floating mass of coke will vary. If it does change, then there must be motion in the mass of metal from time to time.

It would be very interesting to know if the authors have made any estimates as to the effect of circulation on their present calculations. If not, then perhaps there would be value in including this effect on their list of subjects for future study.

The work reported here is the first step of a worthwhile study. It is hoped that both the authors and committee will be able to continue this program.

Professor V. Paschkis: To date, we have not considered any circulation or convection currents. However, provided certain concepts regarding the flow are agreed upon, the influence of such convection on the final position of the isotherms can be explored by computation.

I. P. Bahme: We are intensely interested in the paper just presented. For many years we have been trying to find a practical approach to an understanding of some of the problems affecting lining life. Because our original approach concerned itself largely with alumina silicate linings, our assumptions have largely been based on this type of refractories.

However, as an indication of lining conditions through changes in heat absorption of the cooling water, it matters little what type of lining is used. Our expectation has been to correlate changes in lining thickness with heat absorption of the cooling water, and relate this with the thickness of the lining itself.

Technical data to assist us in this endeavor has been lacking, and conditions do not readily permit measurement of linings during rebuilding — a vital detail in this approach.

Sufficient data about the physical characteristics of the refractories themselves is available to justify the conclusion that the longer an "equilibrium point" within the refractory mass can be maintained at any given point, the longer will be the life of the material. This is characteristic of the material.

Assistance in maintaining a point of equilibrium is given by maximum cooling of the hearth cooling system. This aid, combined with radiation and other sources, influences the changes which the refractory undergoes. Such alterations as the grains of the refractory undergo are a matter of a time-temperature relationship.

While the PCE value (pyrometric cone equivalent) of the refractory lining may be in excess of Cone 34 in its pure state, this value decreases rapidly when mixed with molten iron. At some point on the lining face, the refractory will be in a fluid condition. Resistance to penetration can be accomplished by effective cooling because of the time-temperature relationship mentioned.

Hence, by maintaining maximum cooling efficiency, it is assumed that change in equilibrium point of the refractory lining can be held as near as possible to the inner furnace face. It is further assumed that, as the thickness of the lining decreases, the heat absorption of the lining, as reflected by the water cooling system, will increase. Hence, this change, when correlated with actual lining thickness measurements, can eventually be made to indicate in a practical way an estimate of lining thickness during operation.

Data is based on the Btu/ft/min of hearth plate periphery. The heat absorbed at each section of the hearth cooling system is obtained by measuring the difference between the inlet and outlet temperature of the cooling water, and the rate of flow of water. Pressure readings are also observed to determine variations during test periods. For purposes of comparison, these tests are made both "before" and "after" mechanically cleaning the hearth jackets.

From such measurements, the heat absorbed is calculated by substituting in the following equation:

$Q = C \times W \times (T_2 - T_1)$ in which:

Q = Total heat absorbed per min (Btu)
T_1 = Temperature of inlet water in F
T_2 = Temperature of discharge water in F
W = Rate of water flow through the section in lb/min
C = Specific heat of coolant (equals 1 for water)

The heat absorbed at each section is then divided by the peripheral length of each section in feet to give the final comparative measure used in this work, which is Btu per min per ft of hearth plate periphery.

Records indicate that there is an average variation of 12½ per cent in the Btu/min/ft depending upon whether the cooling coils had been mechanically cleaned. Removing built-up deposits and scale from the cooling coils by mechanical cleaning, increases the heat absorption by 25 per cent and more in many instances. From this it was determined that mechanical cleaning of the hearth cooling coils prior to testing would produce the most reliable results upon which to base calculations.

In full acknowledgement of this work, however, is the fact that it is indicative, and does tend to substantiate work in this field which contended that if sufficient knowledge were available to properly interpret results of the tests, a reasonably accurate understanding of the probable length of lining life could be determined.

For purposes of emphasis, it is meant that as the lining erodes away, the effect of the intensity of the heat will be reflected by the cooling water and can be graphically indicated on the basis of Btu/min/ft of hearth plate periphery. It is not believed possible at this stage of the work completed, to be able to offer much more than simple statements regarding the results.

Notable is the phenomena that most furnaces have a definite characteristic curve when test results are plotted graphically. The characteristic curve is obtained over a period of tests, and deviations from this established curve are reasons for further investigation or suspecting a change in lining thickness at that point.

It is found that on blast furnaces with hearth diameters under 20.0 ft, an irregular heat absorption-curve usually exists as a characteristic of the curve.

Larger diameter furnaces show a characteristic curve with the various heat absorption values more nearly paralleling each other. When these tests were first

started, in furnaces with alumina silicate linings, the values indicated that an average Btu/min/ft of 350 or more would, when translated into an estimate of lining thickness, represent the absence of all effective lining.

As a result of tests made after mechanically cleaning the hearth cooling coils, this figure was assumed to be low since many comparatively new furnaces had average values between 300 and 350 Btu/min/ft and over.

This assumption was further substantiated by the first measurement of actual remaining lining thickness when a furnace was dismantled for rebuilding. The furnace had a 27 ft 6-in. hearth diameter and had produced over 2,750,000 tons of iron.

water circuits was 228. Whether this projection was indicative of an alteration of the lining at this point was to be determined. Further investigation revealed that at the time of testing this circuit, a 2-ft tapping hole existed instead of the normal 6-ft hole.

This incident supported the contention that variations in the distance of molten iron from the hearth cooling plates would be reflected in the heat absorbed by the cooling water.

Another furnace, shortly after being rebuilt with a carbon hearth and bottom, showed one section to have an abnormally high heat absorption value when compared with other sections of the same furnace. The

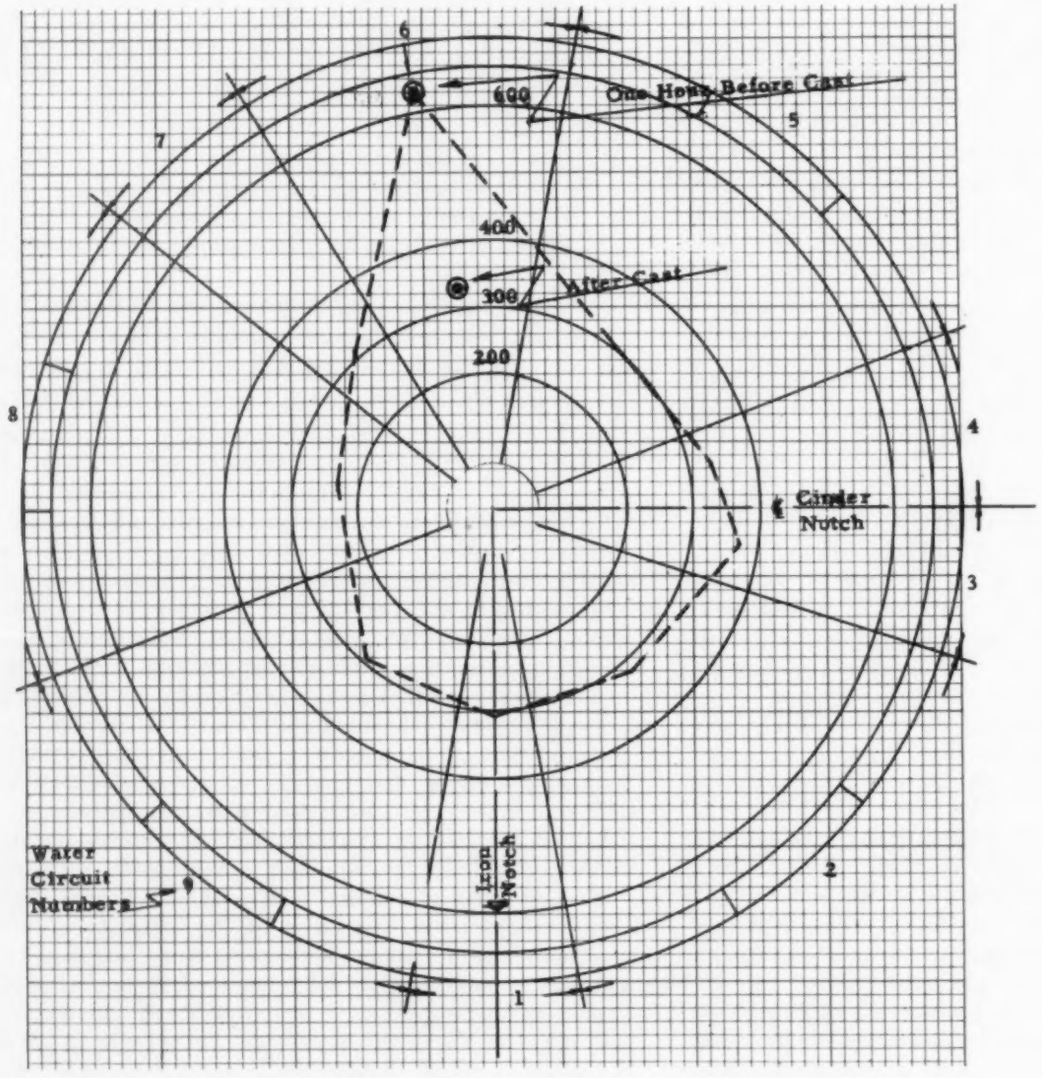

Figure 13 — Curves show Btu transfer per minute per foot of hearth plate periphery and indicates a hot section.

Based on testing results and information available at that time, a remaining lining thickness of 8 to 10 in. was predicted. Actual lining measurements revealed a satisfactory lining averaging approximately 18 in.

These measurements led to changing the value to 425 Btu/min/ft for alumina silicate lining approaching a thickness of zero inches in large diameter furnaces.

A furnace tested periodically during a regular hearth plate cleaning schedule suddenly developed a projection on the heat absorption curve, at a point directly adjacent to the iron notch. The projection value was 474 Btu/min/ft while the average for the remaining

average heat absorption was 367 Btu/min/ft for all circuits except the "hot" section which attained a value of 636 Btu/min/ft. (See Figure 13.) Further tests and observations in relation to this circuit revealed that, before casting, the value of 636 existed. After casting and within approximately one hour of cast time, a minimum value of 325 was recorded. All other circuits remained stable during the fluctuation at the "hot" section.

This situation was interpreted to be due to a point on the hearth lining near the top at this section permitting molten iron to be in closer contact with the hearth

cooling plates. This explanation would be plausible if a block of carbon lining was displaced or if unusual errosion took place at this point. Discussion with blast furnace operators also provided the opinion that a portion of the carbonaceous material which normally covers the inner wall could have broken away. When the molten iron level reached this point, the heat absorption raised. Upon casting and lowering of the iron level, the heat transfer decreased.

This condition presented the problem to the blast furnace operators of, "What shall we do if we find a part of the lining believed to be thin?"

The most recent opportunity to measure lining thicknesses for comparison with test results occurred when a furnace on which previous tests were performed had a "breakout". The hearth was of alumina silicate construction with a hearth diameter of approximately 20 ft. The average daily tonnage was 630 tons. The breakout was near the end of the campaign and a complete rebuilding was ordered. While dismantling the furnace and removing the old hearth, the thickness of the remaining lining was measured and the conditions noted. (See Figure 14.)

The last heat absorption test before the breakout was

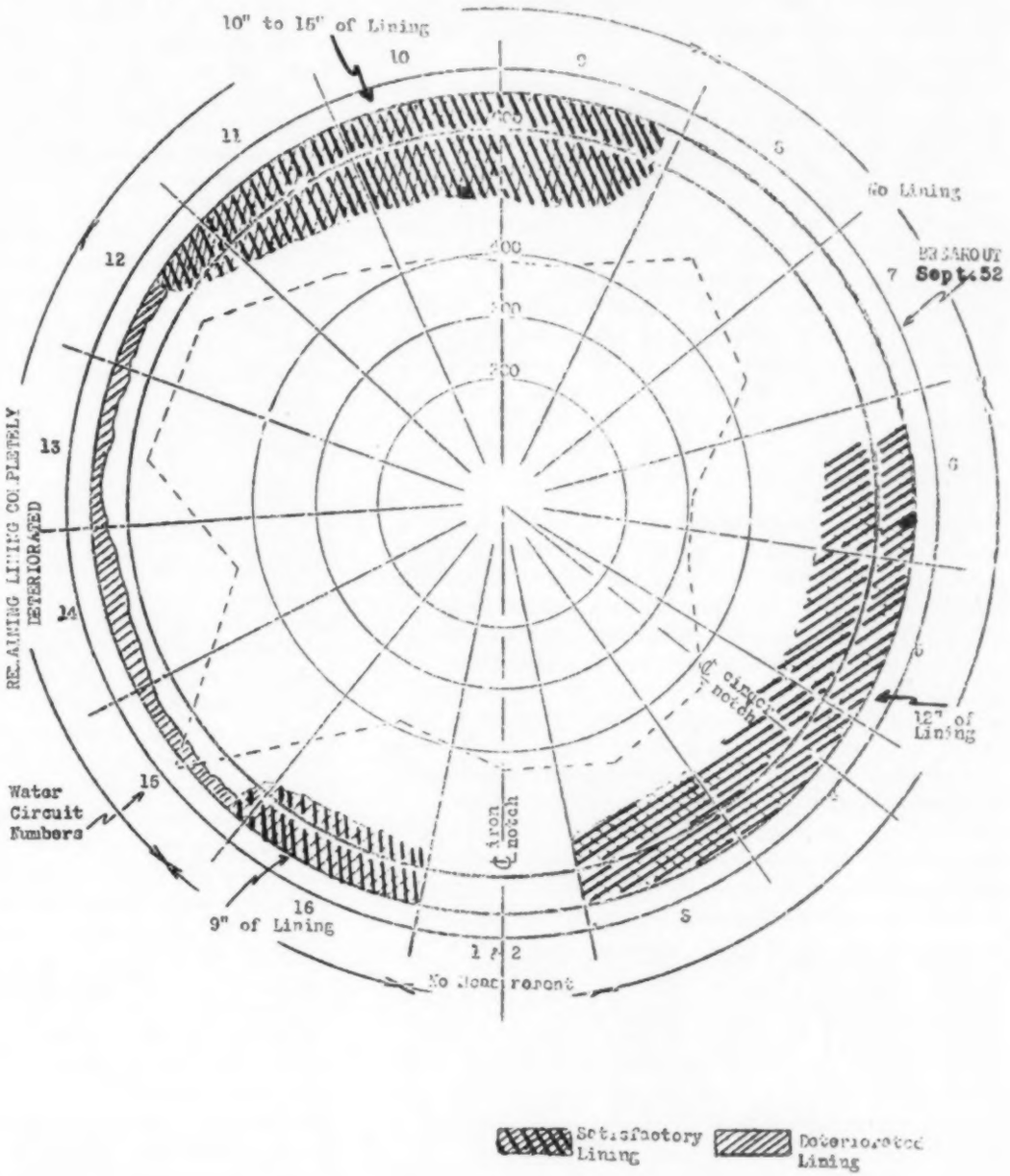

Figure 14—Chart shows actual lining thickness and Btu transfer per minute of hearth plate periphery. Dotted line shows heat transfer curve.

In this case the water circuit consisted of two plates. Increased cooling was attempted by shortening the water circuit in the affected area to include one hearth plate in each individual water circuit, in place of two plates per circuit.

Theoretically, this method was arbitrary. However, the periodic "hot spot" disappeared and has not shown up again.

performed seven months previous. At that time, test results suggested that a thin lining of brickwork existed at most points around the hearth. Six circuits out of a total of 16 showed heat absorption values in excess of 400 Btu/min/ft. No explanation for these high values existed other than a thin lining at these points.

The actual measurements supported the heat absorption tests very well.

Circuit number 7, where the breakout occurred and the adjacent circuit number 8, had no lining at all.

The heat absorption curve had a definite projection at these places.

Circuits 12 to 15, covering approximately one-fourth of the hearth periphery had 2 to 5 in. of deteriorated lining remaining. The brickwork was grey in color, porous, and crumbled very easily. The heat transfer curve covering this area was excessive with one circuit reaching 675 Btu/min/ft. Other circuits near 400 Btu/min/ft had satisfactory brickwork remaining and in good condition.

Had this furnace been tested nearer to the date of the "breakout", it is believed that much higher heat absorption values would have been recorded at the area of the "breakout".

As stated before, the information available at the present time is limited. However, we believe the effort in trying to secure information is a positive approach to the problem. It is believed that if continuous records and examinations are obtained for a sufficient number of furnaces and for a long enough period of time, that the variables encountered at the present time will cease to be matters of important consideration.

It is believed that as additional information is obtained, other facts will be brought to light which will assist not only in determining lining thickness, but will provide data about the cooling system in terms of increased efficiency. From this, the development of more efficient design of cooling systems will be possible, resulting in maximum operating life of the hearth of furnaces.

Professor V. Paschkis: The method for detecting danger of break-outs suggested by Mr. Bahme is interesting. However, several points come to mind. The reference should be the heat loss per unit area rather than that per unit length (perimeter). Another point is, how well the temperature rise over an entire area (one section of the staves) would respond to a local breakout. If the latter is well confined, the rise may be too small to be noticed. This problem can be studied by computation. The third question relates to the reliability of the technique in view of fluctuations of quantity and entrance temperature of the coolant, and of differences in the resistance offered by the "airgap" at different points of the surface. "Airgap" is used here to denote a severance of the lining from the cooling staves.

C. G. Hogberg: I would like to make one or two observations. One has to do with the reference in Professor Paschkis' paper to the need for work on different hearth diameters. I recall an incident, as several in this room will very vividly, when we blew in the first two 25-ft hearth diameter furnaces at South Chicago, in about 1936. These furnaces were provided with a pad of bottom block only nine feet thick.

After about four months, the first furnace suddenly stopped making iron. Everything about the furnace operation was normal, except that nothing came out the tapping hole. When we opened the hole, all we got out was slag and very little of that. In the meantime, a few cracks developed in the foundation, with steam issuing from these cracks, and everybody had a good idea what had happened. After a day and a half of this, we banked the furnace, let her stand for a week, blew up again, and had no further trouble. A few months later, the same thing happened on the second furnace, which was of identical design. It was banked for about a week with the same result.

When the furnaces were blown out after long campaigns (which averaged about 2,800,000 net tons), the salamander removed from the bottom of one furnace weighed about 1700 tons and, in the other 2135 tons. The iron had simply gone through the bottom block and into the concrete foundation.

These incidents gave us a real demonstration as to what we need in the way of hearth bottom thickness for large-diameter furnaces. I think now, with ordinary fire clay bottom block, we are using a minimum thickness of about 15 feet.

The other observation I had was the striking similarity of the 2100 F contours between Professor Paschkis' Design II, which has the horizontal carbon bottom pad as well as the carbon side wall, and Design III, which has the carbon side wall without the horizontal carbon pad.

V. J. Nolan: Dr. Paschkis is to be congratulated for the excellent work he has done and the way he has presented it. The committee that was set up to work with Dr. Paschkis has asked to secure some data on the condition of carbon linings after they had been in service for several years and data of this sort would serve as a guide for Dr. Paschkis in his continuing studies of this subject.

Since our last meeting in New York, I have had the opportunity of inspecting one carbon lining that has been in service for several years with approximately 1,800,000 tons of production on this one lining.

The side walls were constructed with a double course of carbon. Starting at the hearth coolers, we had 3 in. of coke breeze 15 in. of carbon block, a 2-in. tamped joint of carbon ramming paste and then the inside block lining of 13½ in. thickness. The horizontal hearth blocks were laid in two thicknesses, each 22½ in., making a total horizontal hearth thickness of 45 in. The furnace was cleaned out and the salamander removed. On inspecting the carbon we found the side walls intact with a maximum side wall wear of 5½ in., most of which was in the lower wall sections at about the end of the horizontal hearth blocks.

The horizontal hearth blocks were still in place for a distance on the top course of 3½ ft inside the vertical walls. The bottom course of horizontal hearth blocks were still in place extending in approximately 5½ ft inside the vertical wall blocks. In a 19 ft 6-in. diam furnace this would indicate a wearing away of the center portion of the horizontal hearth blocks of 8 to 12 ft, depending on which course you were talking about. This clearly indicates that carbon in the horizontal hearth section does remain in place for a long period of time. Comparing this inspection with other furnaces of larger diameter clearly indicates a definite relationship between furnace diameter and thickness of the carbon in the horizontal sections.

In Germany they employ carbon thickness in the horizontal section of approximately 9 ft, and I feel that we should do more work in that direction in order to get the same long life from the horizontal carbon blocks or brick that we seem to get in the vertical hearth sections up to the top of the hearth jacket.

By WILLIAM T. HOGAN, S. J., Professor of Economics, Fordham University, New York, N. Y.

IMPACT OF TECHNICAL DEVELOPMENTS IN LIGHT FLAT ROLLING ON THE CONSUMING INDUSTRIES

. . . . industries are all interdependent, one upon the other, for their advancement . . . .

▲ THE purpose of this paper is twofold:

1. To discuss the technological developments in the light flat rolled segment of the steel industry.
2. To evaluate the impact of these developments on the consuming industries and the economy in general, and thus show the interdependence of these industries.

The second purpose is of importance, since the impact that a technological development in one industry has on another must be considered, if the full significance of such a development is to be appreciated. This consideration emphasizes the intimate inter-relation of the industries in the American economy. It likewise demonstrates that many of the remarkable developments made in a particular industry are, in part, the result of technological developments made in other industries.

The rather obvious fact of industrial interdependence is often obscured or forgotten when one has occasion to review the advances made in a single industry. An example of this is the average person's consideration of the development of the automobile. This was brought home with particular force in the past few years when the automotive industry commemorated its 50th anniversary with a number of elaborate displays and pageants. These often consisted of a passing parade of motor vehicles starting with Duryea's gas buggy of the 1890's, and continuing with the curved dash Oldsmobile of 1900, Henry Ford's Model T of 1908, the closed car of the 1920's, the all steel body of the 1930's, and finally the streamlined models of the 1950's with automatic transmissions and other improvements. In the review of such a parade one is inclined to center his attention on the advances in automobile manufacture (which have indeed been great) without realizing that these developments could not have taken place unless there had been literally hundreds of mechanical and technological advances in the industries that supply the manufacturer.

The present day automobile is indebted to:

1. The steel industry for its deep drawing cold reduced sheets as well as a number of alloy steels.
2. The chemical industry for the development of a rapid drying lacquer which reduced the time needed to paint automobile bodies from 30 days to a few hours.
3. The rubber industry for improved tires with a life span of 30,000 miles as opposed to the 3,000 mile tire of 1910.
4. The glass manufacturers for shatterproof glass.
5. The petroleum industry for more efficient gasoline.
6. The improved highways of the nation that have contributed much to comfortable riding.

These are but a few of the advances in other industries that made the 1953 automobile possible. Many others could be mentioned.

The same analysis can be made of the major improvements in the light flat rolled segment of the steel industry. The old style hand mill, which was the only means of rolling sheets until the mid-1920's, is medieval in comparison with the hot strip and cold reduction mills of today. Here, in a period of 25 years, we have evidence of remarkable progress, which would have been impossible were it not for a number of concurrent developments in other industries. In this instance there were also developments in other parts of the steel industry which contributed to the result. The modern continuous hot and cold strip mills owe much to the genius of the electrical industry which provided the motors and controls essential to high operating speeds. The mills also are heavily dependent on special lubricants and on high quality steels used in the bearings, which must withstand the tremendous pressures required in cold reduction operations.

The above are but two instances of the interdependence of industry in our economy. Many other obvious examples could be given. However, these two are adequate for purposes of illustration. It is evident, then, that in thinking of the industries in the American economy, we must regard them not as individual, unconnected threads, but rather as threads woven into a fabric in which each is intimately dependent on the others. Consequently, one aspect of our thinking should be in terms of the impact that developments in one industry have on others. Only in this way can we come to a full appreciation of the effects of technological change.

This paper will discuss four technological changes in the light flat rolled segment of the steel industry and indicate the impact they have had or will have on the consuming industries and the total economy. Two of these developments are concerned with the manufac-

ture of tin plate, a third with silicon or electrical sheets, and the fourth with galvanized sheets.

The developments in tin plate manufacture are:

1. Continuous annealing.
2. Differentially-coated electrolytic tin plate.

CONTINUOUS ANNEALING

Annealing is one of the necessary steps in the production of tin plate. Its function is to restore by heat treatment, the ductility of the steel which had been diminished or lost in the cold reduction process.

Box annealing has been the conventional method employed in the manufacture of tin plate and, at the present time, is used for over 90 per cent of the industry's output. In this operation, several wound coils of cold reduced steel are stacked on top of each other, a cylindrical cover is placed over them, and the air inside the cover is replaced with a protective atmosphere. A number of these stacks of coils, usually six, are then covered by a large box shaped furnace. Heat is applied and the temperature rises slowly to a point between 1200 and 1300 F. The steel is soaked at this heat for a number of hours, and then allowed to cool gradually until it reaches room temperature. The entire cycle takes from 5 to 7 days.

Continuous annealing was first introduced in the late 1930's but did not receive widespread acceptance until the late 1940's. It was put in operation in Canada in 1945. In this method, which has several advantages over box annealing, a cold reduced strip of steel enters a heating furnace, makes a series of vertical loops, passes through a cooling zone and is then rewound. The temperature of the heating furnace is 1300 F, and is sufficient to remove the cold working strains present in the strip from cold reduction. The cooling chamber into which the strip passes is maintained at 300 F.

In the most recent installation, the strip enters the furnace at the rate of 1000 fpm and completes the cycle in less than three minutes. At this speed it is possible to process over 25 tons of material per hour.

Because of the qualities imparted to the steel by continuous annealing it may help to simplify one of the problems which confront the can makers, viz., complicated inventory. This problem has arisen from the fact that the number and diversity of products put up in cans require different types of tin plate. The canmaker must have in inventory a wide variety of sizes, gages, tempers and chemical compositions. It is evident that any process which will allow him to reduce the number of items in inventory will be a benefit. Such a benefit should come through the use of continuously annealed tin plate.

The new method of annealing combines hardness and ductility in the steel. Consequently, this steel (tin plate) can be used to make a variety of cans that formerly required 3 grades of hardness or temper. A reduction may also be made in the number of chemical compositions. Since the continuous annealing process is relatively new, it is not yet clear to what extent it will simplify the canmaker's inventories; however, it is certain that a significant simplification can be achieved.

A further advantage of continuous annealing is in the speed with which the process is completed. The three minute cycle as opposed to the five to seven day cycle for box annealing speaks for itself. This advantage is even more pronounced in the summer months when tin plate is in greater demand, and box annealing is slower because of the length of time needed to dissipate the heat.

DIFFERENTIALLY COATED TIN PLATE

The second development, differentially-coated tin plate, is a recent one. It was made possible by, and is a further modification of, the electrolytic tin plating process.

The electrolytic process for manufacturing tin plate was put in operation on a commercial basis in 1937. Production was extremely limited for the first few years, and it was not until the outbreak of World War II that the full potential of this process was realized. It solved one of the major problems facing the country at that time, viz., the conservation of tin.

Until 1941 virtually all tin plate was made by the hot dip process which consisted essentially of passing cut sheets of steel through a bath of molten tin. This method required 1¼ to 1½ pounds of tin for every hundred pounds of steel. The electrolytic process, which consisted basically of passing a continuous strip of steel through a series of electrodes that deposit tin on the steel surface, was capable of producing satisfactory tin plate with a coating of ¼ to ½ pound per hundred pounds of steel. Thus by using the new method, much more tin plate could be produced with the same amount of tin.

The experience with the use of lighter coated plate was so satisfactory that this wartime emergency method has since become the accepted means for making most of our tin plate. Today, about 70 per cent of the industry's output comes off the electrolytic lines.

In 1950 the war in Korea brought government restrictions on the use of tin. Conservation of tin was again necessary. This, however, was not easy to achieve because light coated electrolytic tin plate had already replaced much of the hot dipped plate. The only possibility for conserving tin seemed to be in reducing the number of those containers which still required the heavier coatings of hot dipped plate for satisfactory shelf life. The heavy coat was necessary for the inside of the container, but not for the outside. If plate could be made with a heavy coating on one side, and a light coating on the other, it would be a means of saving tin. This prompted the steel industry to develop differentially-coated electrolytic tin plate.

Differentially coated plate could only be made satisfactorily by the electrolytic process which permits the deposition of tin according to scientific laws. A specific current will deposit a specific amount of tin on the surface of the steel. Further, the current can be controlled so that different amounts of tin are deposited on the two surfaces of the strip.

A theoretical and laboratory solution to the problem of differentially coated plate was found quite readily; nevertheless, a member of practical difficulties remained. There was the fundamental question of how heavy the coating on each side should be. After consideration it was decided that ¼ pound coating would be adequate for the outside of the container. This de-

cision was based on experience with containers carrying ¼- pound coating. A more difficult problem, demanding extensive research, concerned the amount of tin to be used on the inside of the can. As the result of much experimentation, it was decided that a one-pound coating deposited electrolytically would be sufficient protection for many fruits and vegetables which were ordinarily packed in 1¼-pound hot dipped plate. Thus the differentially coated tin plate carried one pound on the inside and ¼ pound on the outside. The average coating was 0.625 pounds as compared with 1¼ pounds for the hot dipped material. The saving of tin was 0.625 pounds per hundred pounds of steel, a significant amount.

Another very practical problem was the proper identification of the two differently coated surfaces. It is absolutely essential that the heavy coating be used on the inside of the can. Tin cans are produced at high speeds so the two sides must be readily distinguished in order to detect an error immediately. Further, the identifying mark must not jeopardize quality or interfere with the sales appeal of the packed container. A number of ideas have been tried. One of the most popular methods in use today consists of a difference in lustre, the heavily coated surface being mirror-bright while the lightly coated surface is satin-dull. This method offers the possibility of positive control in the tin mills and can plants by means of reflectometers which are capable of detecting slight differences in reflectivity as the strip or cans move by at high speeds.

A third problem is concerned with the operation of the electrolytic line. Most lines were designed for lightweight coatings. Many of the latest ones have been engineered strictly for quarter pound coating. This has meant limited current density and, therefore, very slow operating speeds when the heavier coatings, such as the one pound and the quarter pound differential, are being produced. Obviously some adjustment will have to be made so that faster speeds can be attained for the heavy coated plate.

Production of this new product has been relatively small and may not exceed 200,000 tons for this year. It is too early to evaluate the impact of this development on the can manufacturers or the economy in general. Some estimates have been made that indicate the possibility of saving 20 to 50 per cent of the tin now used for hot dipped plate. Such a saving could have an effect on the price of containers, and aid considerably in the conservation of tin, a metal for which we are wholly dependent on the outside world.

GRAIN ORIENTED SILICON SHEETS

The discovery of the iron-silicon alloy by Hadfield at the turn of the 20th century was an outstanding contribution to the development of the nascent electrical industry. Silicon steel in the form of laminated sheets replaced iron and carbon steel as the core material in transformers, motors and generators. The advantages of this new alloy were:

1. It reduced core losses considerably. Core loss is the amount of electrical energy converted to heat and dissipated uselessly when a material is magnetized with alternating current.
2. It increased the permeability, i.e., the ease with which the magnetic lines of force passed through the core.
3. It virtually eliminated magnetic aging, i.e., the deterioration of the magnetic properties of a material which comes with increased time and temperature. When a material ages magnetically, its core loss increases and its permeability decreases.

Hand rolled silicon sheets were first made in 1902, and from that time forward there was a consistent improvement in their quality. The improvement, however, was in the core losses only, as little or no advance was made toward bettering the permeability of the steel.

Early in the 1930's, experiments revealed a remarkable improvement in the magnetic qualities of silicon steel in the rolling direction when it was produced in continuous coils and subjected to a series of cold reductions with intermediate annealings. Core loss was lowered and permeability greatly increased. The improvement was caused by better grain alignment in the rolling direction. Equipment manufacturers soon took advantage of this by designing and constructing the cores of transformers in such a manner that, when in operation, the lines of force flowed only in the rolling direction of the sheets.

Continued experiments and intensive research during the past decade have resulted in a high quality grain oriented steel. The following comparison gives evidence of the advance made:

	Maximum core loss, watts per lb @ 15 kg	Permeability @ 15 kg
Best grade hot rolled	1.10 max	400–425
Grain oriented 1938-1940	1.00 max	3,500
Grain oriented 1953	0.73 max	17,000

Grain oriented sheets are usually produced from open hearth steel with a 3 to 3½ per cent silicon content. The steel is reduced to coil form on the hot strip mill, after which it is oiled and pickled. The coil is then cold reduced to an intermediate thickness which is between 60 and 70 per cent of the final thickness. For example, the strip is about 0.080 in. thick when it comes off the hot mill and is cold reduced to between 0.030 and 0.025 in.

The next step in the process is continuous annealing at a temperature between 1500 and 1700 F. The material is then subjected to a second cold reduction in which it is brought to the final thickness. The amount of this reduction varies between 40 and 60 per cent so that the final product is about 0.014 of an inch thick. A second continuous annealing follows in order to recrystalize and decarburize the steel. Decarburization is a major function of this operation as the carbon content should be no greater than 0.006 per cent to obtain optimum grain orientation and magnetic properties.

At this point in the process, the product is sometimes sold to customers who have high temperature annealing facilities, but usually the sheet producer performs a last annealing. This is a box annealing at a temperature of about 2000 F in an atmosphere of pure

dry hydrogen. This final operation is necessary to obtain the desired magnetic properties and grain orientation.

Grain oriented steel has been used principally in the manufacture of transformers, although in the past few years its use has been extended to large generators. Its main advantage is that, by proper design, a unit of equivalent rating can be made smaller than would be possible if hot rolled transformer sheets were used. Grain oriented steels are more expensive, but an economic advantage is realized through the use of less silicon steel, less copper and smaller size outer coverings for the transformer. The following comparison gives some idea of the weight saved in a transformer by the use of grain oriented steel as opposed to the hot rolled silicon sheet:

Transformer size, kva	Core weight HR steel, lb	Core weight grain oriented steel, lb	Total weight HR steel, lb	Total weight grain oriented steel, lb
5	69.2	43.8	275	170
15	163.1	95.5	475	385
25	208	127	610	458
50	409	212	1400	875
75	463.6	300	1950	1118

The actual saving in materials that has resulted is of great significance, particularly when one considers that one of these materials is copper. The reports of transformer manufacturers differ to some extent but a good average for material savings would be in per cent:

	Core steel	Copper	Structural and tank steel
Distribution transformer	25	25	20
Small power transformer	18-20	12-15	13-15
Large power transformer	15	10	10

It is evident that this development by the steel industry has had a considerable impact on the producers of electrical apparatus. It has not only allowed them to save on materials, but has also given them a superior steel to work with. The result is a true increase in productivity, and consequently an increase in real wealth, for the same results can be attained with less expenditure of material. Further, the saving of copper is important because of its expense and relative scarcity.

CONTINUOUS GALVANIZING

Since 1950 the steel industry has supplied the American economy with more than 2,000,000 tons of galvanized sheets each year. This corrosion resistant product has a variety of uses in industry and on the farm. Some of these are:

1. Siding and roofing in construction.
2. Stock tanks, corn cribs, grain bins, implement sheds, poultry houses, etc., on the farm.
3. Freight car roofs and interiors.
4. Culverts.
5. Smaller miscellaneous items such as garbage cans, ash cans, pails, laundry tubs, etc.

From these examples it is evident that galvanized sheets are put to use in those areas where resistance to corrosion is a primary requisite. This demands that the steel base be sufficiently protected by the zinc coating. Consequently, the coating must be adequate in thickness, uniform in coverage and tenacious in adherence to the steel.

Until the close of World War II, the steel industry produced galvanized sheets exclusively by the hot dip method. The process consisted essentially of passing sheets, cut to length, through a bath of molten zinc after the steel had been subjected to a number of treatments to provide a surface free from oxidation. This is necessary to assure satisfactory adherence of the zinc coating.

The hot dip method is still widely used in the industry. The steps prior to the actual coating vary depending on whether or not cold reduced steel is used. If the steel has been cold reduced, it must be cleaned to remove any lubricating solution containing oil since its presence would have an adverse effect on the coating. After cleaning, the steel is box annealed, temper rolled, and sheared. In the final preparation before coating, the cut sheets are pickled in a hydrochloric acid solution and then rinsed thoroughly to remove any trace of the acid. They are then fed into the coating pot one at a time.

Both the hot dip method and its product, although adequate for many uses, have their limitations. In an effort to remove these limitations the industry developed the continuous galvanizing process. In this method, all the operations needed for preparing and coating the steel take place in one continuous line. Thus the coil of cold reduced steel is fed into the line, cleaned, annealed, coated, cooled and sheared to length without intermediate handling. The final pickling and rinsing of the hot dip method are eliminated.

The new continuous method has a number of advantages over the hot dip process.

1. From the operating point of view, it cuts down on labor cost because the material is not handled between operations.
2. It deposits a more uniform coating on the strip than the hot dip method deposited on the individual sheets. This is due in part to the fact that the coating rolls in the zinc pot are under continuous uniform pressure as the strip passes through. In the hot dip process, on the other hand, the coating rolls constantly separate and join as the individual sheets pass through at intervals.
3. In the continuous process, the strip passes through a long heating furnace where it is annealed. From this furnace, with its controlled atmosphere, the steel is immediately plunged into the coating pot. Thus the surface is kept free of oxidation and better coat-adherence is obtained.

The continuous galvanizing process has provided a superior product for the consumer. In general there is better coating adherence which eliminates or mitigates flaking in the forming operations. Further, the use of continuous annealing and the omission of temper rolling has increased ductility in forming. In particular, the product gives superior performance on freight car roofs and can now be used in new applications such as automobile mufflers where severe bending is required.

Here again a technological improvement has resulted in improved operating practice, a superior product and a saving in raw materials, since less zinc is needed because of the more uniform coatings.

SUMMARY

The four developments discussed can be considered as four isolated instances of technological advance. As such, each is important enough to command a paper in itself. However, they are more than isolated cases; they are part of a technological revolution that has been in progress in this country since the turn of the century. This revolution has affected every industry in the economy, and has resulted in continually higher productivity with a consequent increase in real wealth and the standard of living. It has likewise been responsible, in great part, for victory in two world wars.

The foregoing have been the results of the technological revolution. The question might well be asked—what has been its cause? This answer is not easy to determine with accuracy. It could be said that the cause is competition—that new developments are sought to lower costs, render better service and provide a superior product in order to obtain a greater share of the market. Furthermore, when one firm improves its position it is necessary for the others to do likewise or fall by the wayside. This is entirely true but it is not an adequate explanation.

Another explanation offered for the technological revolution is the profit motive or incentive. Money is invested in improved machinery so that additional profit can be made through the sale of new and improved products. This is likewise a fact, but again does not give an adequate explanation.

The two factors, competition and the profit motive, have been powerful influences in the development of American industry. However, I believe that there is something else, something more basic and fundamental than competition and the profit motive. These two factors have been present in other countries and other cultures, but the same technological revolution did not take place. It may be said that they did not have the resources and capital that this country has, but it must be remembered that the technological revolution started in 1900 when the United States still looked to Europe for capital.

The explanation lies, I think, in a philosophy or an attitude that is almost peculiarly American. Manufacturers in other nations have too often limited their horizon, being content to take a higher profit on a few units, while accepting a relatively static economy. The American, on the other hand, has been characterized by a willingness to accept and even seek change. Our society has been permeated by a dynamism, a refusal to stand still, and a confidence in our ability to conquer and solve future problems that may arise because of change. Add to this the constant desire to explore new areas and we have an explanation of the technological revolution.

With a spirit of enthusiasm for hard work we pushed the American geographic frontier back to the limit. About 1900, with the same spirit we began to push back the technological frontier, and many believe there are almost no limits to what can be done in this area. The pioneer had a great impact on the society of the 19th century, the engineer and technician have had, and will continue to have a great impact on the society of the 20th century. It is the responsibility of the engineer and technician to assure the country of a continuing technological advance which will mean constantly improving productivity, conservation of our raw material wealth, and a higher standard of living.

DISCUSSION

PRESENTED BY

J. K. KEOGH, District Manager, Allis-Chalmers Manufacturing Co., Pittsburgh, Pa.

WILLIAM T. HOGAN, S. J., Professor of Economics, Fordham University, New York, N. Y.

ROBERT B. MENEILLY, Assistant to Manager, Tin Plate Sales, United States Steel Corp., Pittsburgh, Pa.

J. K. Keogh: I have a couple of questions I would like to ask and the first concerns productivity which you mentioned in your paper. Would you comment on productivity generally and indicate what you think is responsible for it? Also where will the money come from for technological improvements?

William T. Hogan: The four developments discussed this morning were part of a technological revolution that has been in progress in this country for half a century. One of its principal effects has been increased productivity, which has assumed more significant proportions since the end of World War I. Consequently, since productivity has played such an important role in our company, it would be well for us to clarify our understanding of it.

First, let us establish a definition of productivity. This is necessary since there is a tendency to confuse it with production. The two are not the same. Production is output, i.e., the number of units produced. For example, we say steel production was 97 millions tons in 1950. Productivity, on the other hand, is a ratio between input and output. It is the relationship that production bears to any or all of the input factors. In other words, it is a measure of efficiency. The input factors to which production is related are labor time (which includes the time of everyone from the hourly paid wage earner to the president), raw materials and capital equipment.

Productivity in the steel industry is usually measured in terms of manhours per ton of steel produced. This figure, however, represents more than labor productivity since it reflects not only the efforts of labor, but also any improvement in capital equipment and raw materials. Thus any change in the manhour per ton figure can be the result of a change in any or all of the three input factors. A better machine, improved raw materials or more efficient application of labor can, and under normal circumstances should, result in more tons per manhour.

From the foregoing it can be seen that a favorable or

unfavorable trend in manhours per ton gives us the effect of some change or series of changes in the input factors but does not give the cause. Thus any adequate consideration of productivity must get beyond the mere manhour figures to the reasons for the change.

In the steel industry much of the increase in productivity can be attributed to the installation of new and improved capital equipment. However, it would be presumptious to assign the entire cause to the new machine, since other items such as better raw materials, more efficient application of labor, and improved scheduling are involved.

The four technological advances I have described have been responsible for an increase in productivity in the light flat rolled segment of the steel industry, while one of the four, viz., that which resulted in the improvement in the production of silicon sheets has been responsible for an increase in productivity in the electrical industry. With the new grain oriented silicon steel sheet, the electrical manufacturers are able to produce a transformer with a rating equal to that of older models but with a saving in raw materials. This is a real increase in productivity and a real increase in our national wealth, for now the same result is accomplished with the expenditure of much less steel and copper.

Since new and improved capital equipment is, in great part, responsible for increasing productivity, it is important that industry continue to install this equipment. However, the high cost of new machinery presents a problem. This is not only a matter of concern in plant expansion, but also in the replacement of worn out and obsolete facilities. For example, a piece of equipment installed at a cost of one million dollars in 1928, 25 years ago, which has been depreciated at the rate of 4 per cent per year must be replaced today if the firm is to continue its operations. However, the firm has only accumulated a depreciation reserve of one million dollars to replace the facility and now discovers that the replacement, although considerably superior to the old facility, will cost two to two and a half million dollars. Another million and a half must be raised to keep the business operating.

This problem of equipment cost has forced many producers to operate with relatively obsolete machinery with a consequent loss in productivity. Thus the question of raising new capital is of prime significance in improving technology and increasing productivity.

The additional capital could come from several sources. It could be borrowed, but many steel companies are loath to saddle themselves with heavy fixed charges which could become a severe burden in periods of low income. As alternatives to borrowing, some companies have sold stock while others have reinvested profits. Suggestions have also been made to revise the tax laws so that a larger depreciation write off may be permitted. This would allow the company to accumulate the replacement value rather than the initial cost of the facility.

These are merely some indications of possibilities for obtaining the money necessary to improve technology and productivity. An adequate discussion would require more time than I have available now.

Robert B. Meneilly: It is good to be reminded again that other industries have contributed so much to the advancement of the steel industry. We in the steel industry certainly recognize this, as do so many people in this room who have contributed much to the advancement of these things Father Hogan has mentioned.

My question has to do with economics of operating continuous annealing. I recall continuous annealing in the early 30's, which at that time was a globular furnace. It turned out a wonderful product but it was entirely too costly. Since that time, the cost of operating continuous annealing has been in a large way a retardant to rapid expansion of the process; so, I wonder if Father Hogan could give us something enlightening on the present situation.

William T. Hogan: It is true that the cost of continuous annealing has been from 70 to 100 per cent higher than box annealing. However, looking at the overall picture in the long run, there are a number of possibilities of reducing the cost. First, plans have been made to incorporate additional operations in the continuous annealing line. One such operation is cleaning the strip before it enters the furnace. Thus one handling would be eliminated with a consequent saving. Another bright spot in the cost picture is the increase in the speed of the lines. Earlier speeds of 500 fpm have been stepped up to 1000 fpm with a beneficial effect on the cost.

Perhaps not as tangible as the two previous examples, but nevertheless of real influence is the fact that the continuous annealing cycle of less than three minutes is operative all year round, while the box annealing cycle of five to seven days is prolonged in the summer months when the demand for tin plate is particularly heavy. A further factor which has yet to make its influence felt is the reduction in can makers' inventories. The extent to which this can be a saving will be determined as the use of continuously annealed tin plate grows.

These are four possibilities of reducing the cost so that it will be less out of line with the cost of box annealing.

Robert B. Meneilly: We within the industry are very much interested in differentially-coated electrolytic tin plate. You pointed out that the present lines were not particularly economical from the standpoint that they must be operated at slower speeds.

Could you comment as to what is happening within the industry to meet the demand for this new product?

William T. Hogan: Within the industry several electrolytic tin plating lines are being planned for the exclusive production of differentially coated tin plate. They will be equipped with the proper plating and tank capacity as well as the proper current density. These lines will be run at a speed fast enough to make the operation economical. In addition to the new lines, those now in operation are being adjusted to produce differentially coated plate as well as the present uniformly coated product. The adjustment consists of the addition of tanks for plating and more current.

These developments should equip the industry with sufficient capacity for the production of differentially coated plate so that we will ultimately save between 20 and 50 per cent of the tin now consumed in the manufacture of hot dip plate.

HEAT PROCESSING IN INDUSTRY— FACTS AND FIGURES

By FREDERIC O. HESS
President
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Philadelphia, Pa.

. . . . advancements in design are bringing furnaces to the point where they may be used as a precision tool with high accuracy and reliability . . . .

▲ THE title of this presentation is purposely broad—to allow a desirable leeway, and afford an opportunity to present and discuss some fundamental concepts of industrial heating requirements. However, some limitations do apply and should be understood and noted at the outset. Only fuel-fired processes and equipment will be presented, and since it serves the broad purpose of this paper, examples of gas firing have been selected, although projections and conclusions are not necessarily limited to this fuel— as will be evident to any one experienced.

For proper evaluation of heating effects and possibilities, a clear understanding of heat transfer seems necessary. We are here primarily concerned with furnaces, and also with temperatures in the elevated ranges of let us say 1000 to 2600 F (in contrast to low temperature heating 300 to 1000 F). It is important to establish the fundamentals of the heat transfer we are confronted with, the effect and control of which underlie and govern our furnace operations.

In a fuel-fired furnace, heat is transferred to the object by wall radiation, gas radiation, gas convection and sometimes by conduction. Such is the general concept, and it is also accepted that the relative importance of the various modes of heat transfer depends upon the furnace temperature employed, the particular furnace design and the means for converting the energy input into heat.

It has been established for some time that in the upper temperature ranges, radiation is the most influential mode of heat transfer—but it has also been found that heat processing cannot be practiced without control—control of heat transfer rate—control to suit the material and object to be heated and to get the results which are expected or must be obtained from the heating process. That is what distinguishes heat processing from mere heating to temperature. Therefore to practice heat processing and to design and develop equipment for the purpose, it seems essential to know and understand what the exact relationship is between radiation and convection, etc., especially in modern non-luminous flame fired equipment. Only then can we design for and practice process control.

To explore the heat transfer mechanism and to determine the relative percentages of heat transfer by wall radiation, gas radiation and convection in such a furnace structure, we conducted an extensive and careful investigation. The details of these tests and analyses are beyond this presentation, and are being reported separately in a special report and paper—but the basic findings and conclusions are pertinent in any consideration of heat processing and to the various examples cited later.

Without outlining exact details of construction, measurements and calculations of this research, Figure 1 shows the final curves of heat transfer for non-luminous fired furnace chambers having wall temperatures of 1750, 2010 and 2100 F.

This chart indicates that approximately eighty per cent of the heat is transferred to the object by radiation from the furnace walls, and the remainder by gas convection and gas radiation. The percentage is reduced, of course, as the object approaches wall temperature because, as you will note, gas temperature is higher than wall temperature.

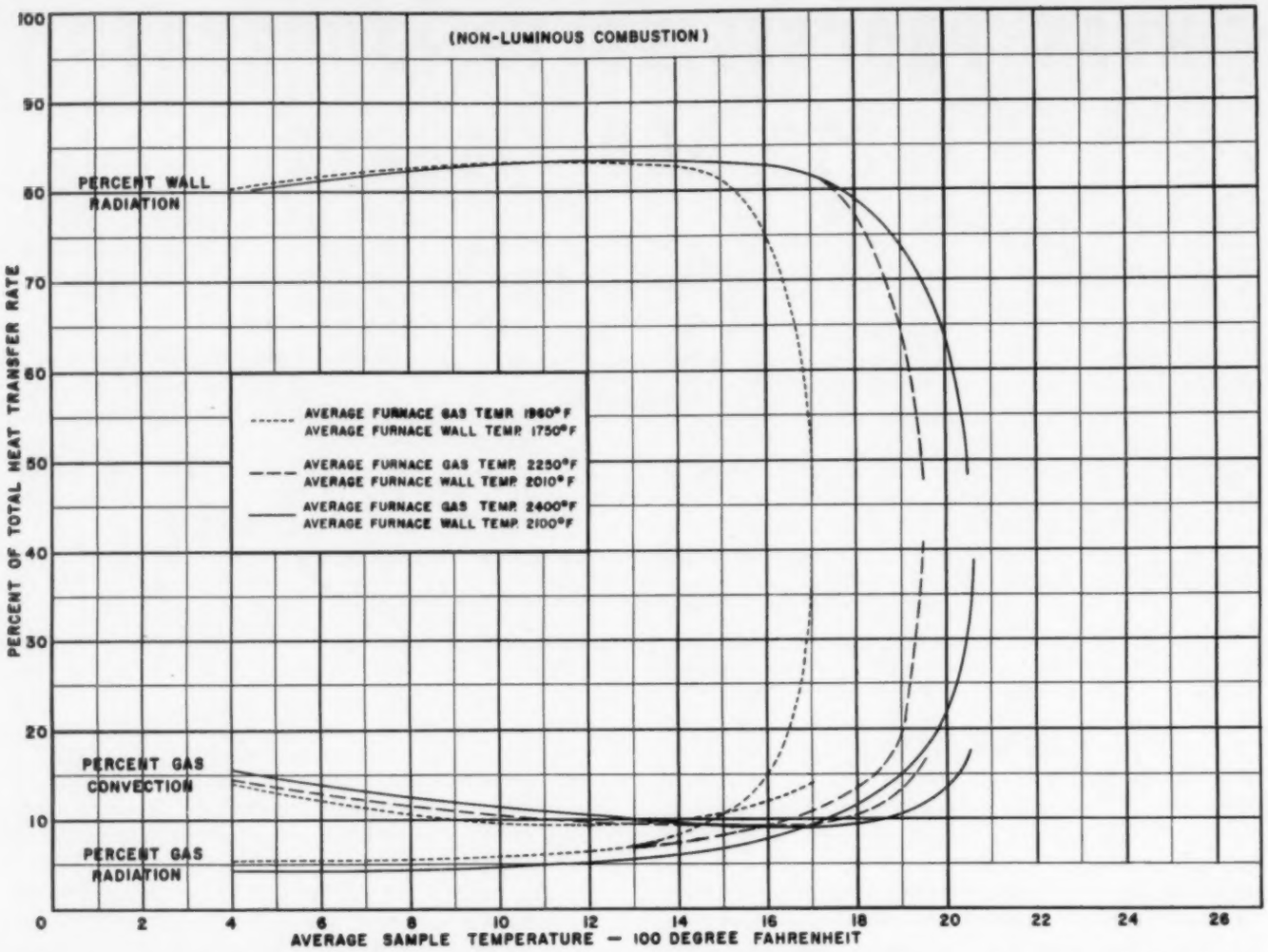

(NON-LUMINOUS COMBUSTION)
PERCENT WALL RADIATION
PERCENT GAS CONVECTION
PERCENT GAS RADIATION
AVERAGE FURNACE GAS TEMP. 1960°F
AVERAGE FURNACE WALL TEMP. 1750°F
AVERAGE FURNACE GAS TEMP. 2250°F
AVERAGE FURNACE WALL TEMP. 2010°F
AVERAGE FURNACE GAS TEMP. 2400°F
AVERAGE FURNACE WALL TEMP. 2100°F
PERCENT OF TOTAL HEAT TRANSFER RATE
AVERAGE SAMPLE TEMPERATURE — 100 DEGREE FAHRENHEIT

Figure 1 — Curves for heat transfer rates in a gas-fired furnace show that 80 per cent of the heat is transferred by radiation from the furnace walls.

This eighty per cent factor obviously puts the emphasis on radiation, and the necessity and desirability to generate radiant energy and control it. That seems logical on a mere proportionate eighty to twenty per cent basis—neglecting any other possible benefit derived from radiation, such as speed, directional control and penetrating power through surface films or manipulation of absorption rate.

Let us now review some actual application in industry, and critically review whether this logic is not only sound—but also practical, and whether the effects are valuable and explainable, desirable and noteworthy.

We may start with a relatively simple heat processing problem—heating of a seven-inch square 0.73 per cent carbon steel billet to 2200 F rapidly to reduce scale and decarb.

Figure 2 is the heating curve and also the wall temperature. The effect of the cold billet upon the furnace wall is clearly evident, an initial drop of 300 degrees from 2500 to 2200 F, then recovery to 2400 F, at which temperature the billet was held, and then the radiating wall furnace was reduced in temperature, as the surface of the billet approached final temperature, to prevent overheating while waiting for the center to come to temperature by conduction. These curves also show the effectiveness of high temperature radiation to reduce the lag when passing through the critical range—which lag is quite apparent and retarding in the center. It should be mentioned and noted that in spite of the 500 degree differential between center at 1400 F and

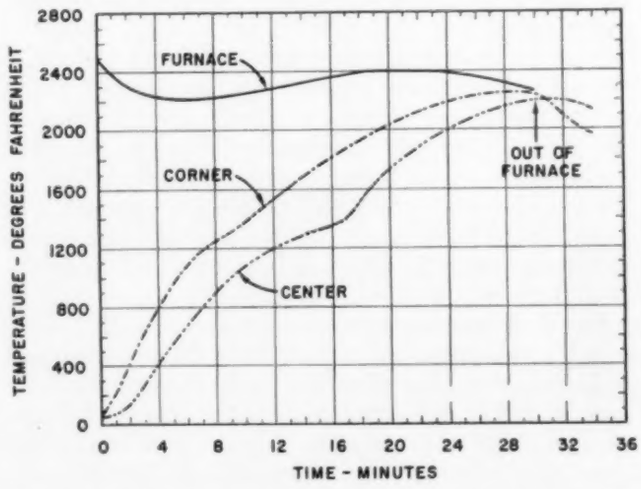


Figure 2 — Heating curves for 7-in. square steel billet with 0.73 per cent carbon.

surface at 1900 F no internal defects could be found in this continuous cast high carbon billet after this heating operation.

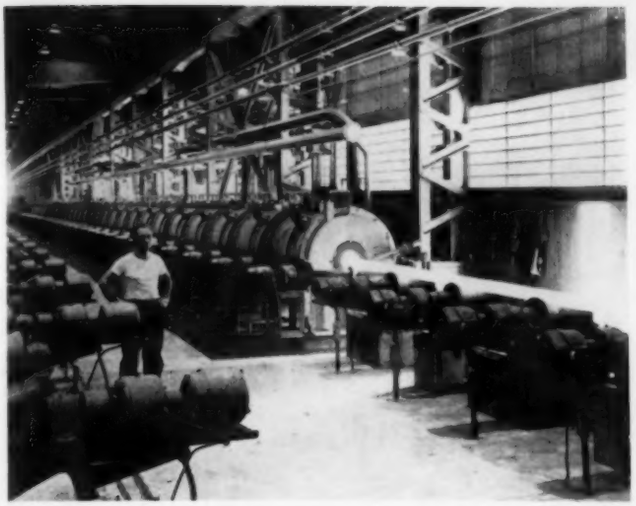


Figure 3 — The barrel furnace was quickly adopted by the industry for tubular products.

To practice this technique in industry we apply the so-called barrel furnaces in continuous line, which is illustrated by Figure 3.

A more recent installation of different design and handling principle, but still depending mainly on wall radiation for heat transfer and control is shown in Figure 4.

The billets are hung and conveyed between two radiant walls. Incidentally this installation, because of the use of the billets for extrusion, has taught us a great deal about the essentiality of uniform heating for a precision process and product.

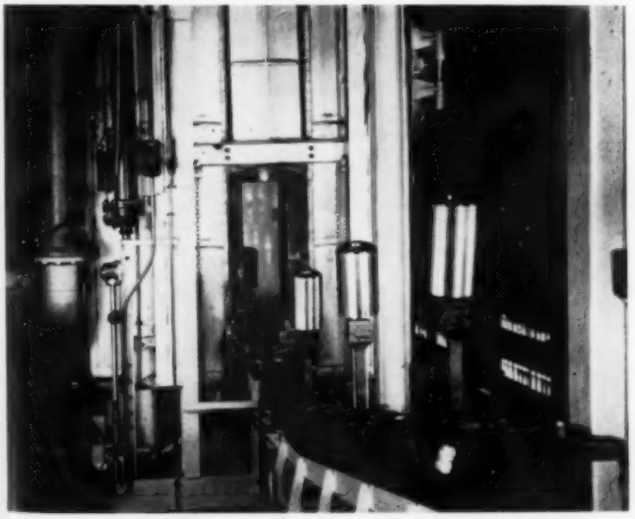
Figure 5 shows another unit mainly dependent on wall radiation.

But let us go on with facts and figures and our scrutiny of heat process control and radiation. One of the most deliberate and effective challenges is represented by the following actual specification:

1. Preheat to 1000 F a heavy steel section of the following composition:

C	Mn	P	S	Si	Cr	Ni	Mo
0.32	0.74	0.038	0.034	0.36	2.8	0.08	0.42

Figure 4 — Furnace shown depends mainly upon wall radiation for heat transfer.



2. Then heat one face only to hardening temperature so that the *surface* does not exceed 1750 F (to prevent grain coarsing), and maximum temperature 3-in. below the surface is to be 1600 F.
3. After the 3-in. depth has reached 1600 F, soak for

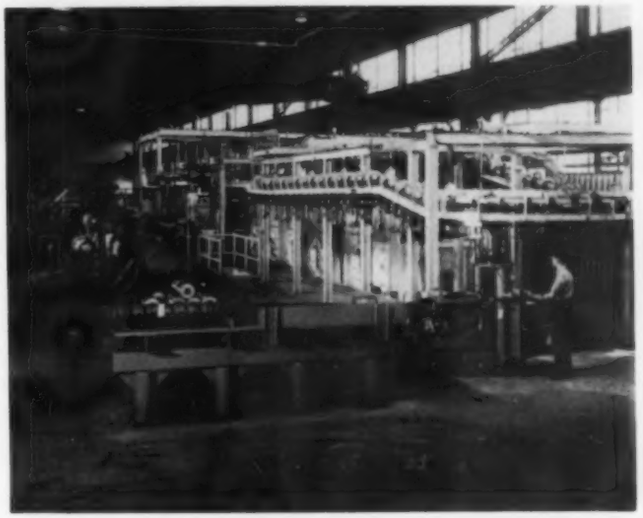


Figure 5 — This unit also depends primarily upon wall radiation for heat transfer.

one and one-half hours at 1600 F to permit sluggish chromium carbides to go into solution and diffuse uniformly. However, as close as possible below the 3-in. depth, a maximum temperature of 1450 F (lower critical) should exist to prevent carbide solution at greater depth which will mini-

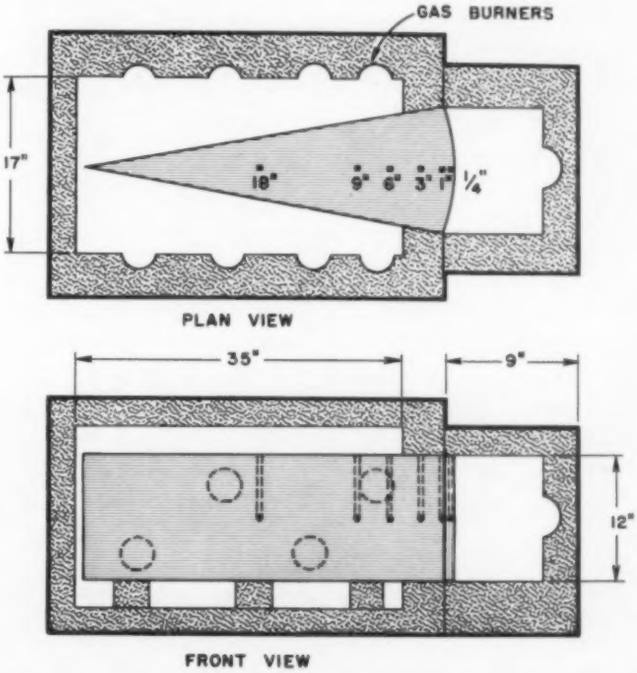


Figure 6 — Sketch shows burner arrangement and thermocouple positions for heat treatment of steel segments.

mize development of internal stresses during quench and confine ultimate hardness of approximately Rc 52 for this steel to 3-in.

4. Quench this heated surface only and then temper

the entire piece at 900 F for two and one-half hours to prevent subsequent cracking.

There you have it—hardly a conventional heating job—but rigid and, to put it mildly, it has unusual heat processing requirements.

Figure 6 is a diagrammatic illustration of the equipment used to satisfy our "tough specificationist." The steel price appears as a segment with a twelve-in. face, about 34-in. long. The side burners, four on each side, were used for preheat and draw only—while a single radiant burner in the front section was expected to heat the face. It can be noted that the front furnace section is a separate structure, removable to apply the quench nozzle. All operations were hand controlled, but temperatures were recorded with electronic instruments. There were six thermocouples inserted along the center line, the 0 couple being one-quarter inch below surface; No. 1 one inch below; No. 3 three inches below, and so on. These are the figures—now let us look at the facts.

Figure 7 shows the heating curve for each of the thermocouples during the face heating operation and the quench cycle. The jagged line represents the burner pressure in inches of water which was adjusted between sixty inches and two inches. Over-adjustment accounts for the two dips in the readings of 0 and No. 1 couples, and could of course be avoided with automatic temperature control, but they serve to illustrate the response to radiant heat transfer. It can be seen that it proved possible to hold the surface below 1750 F and still bring couple No. 3 to 1600 F and keep it there for one and one-half hours. This entire cycle, afford an interesting study in heat transfer and heat conduction.

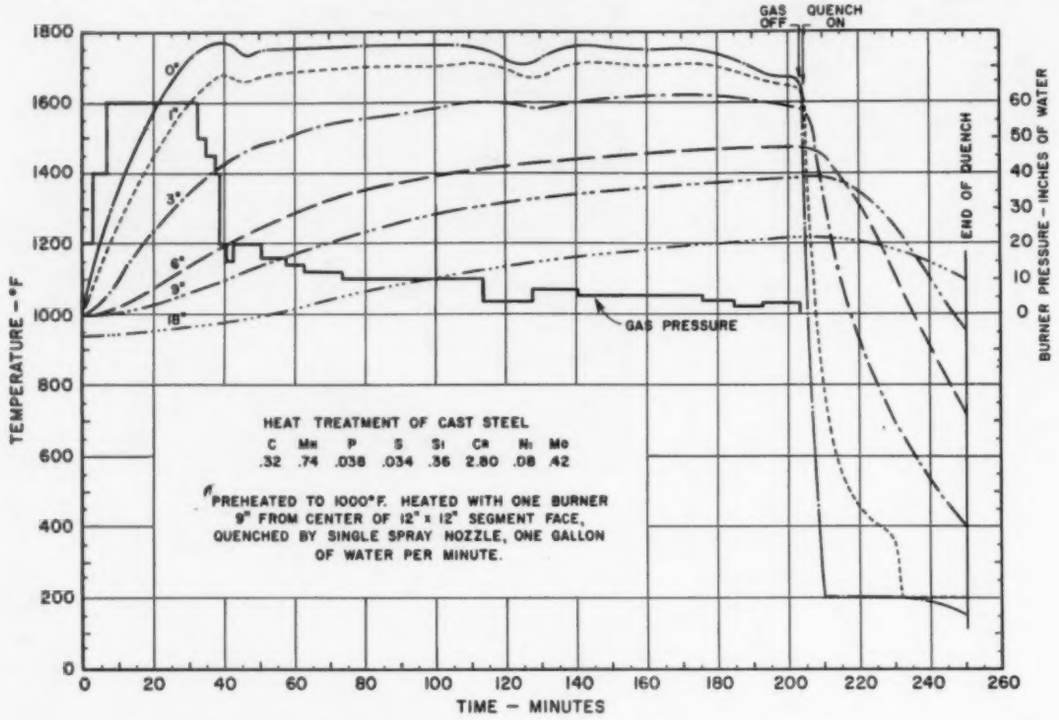

GAS OFF
QUENCH ON
END OF QUENCH
GAS PRESSURE
0"
1"
3"
6"
9"
18"
TEMPERATURE - °F
BURNER PRESSURE - INCHES OF WATER
TIME - MINUTES
HEAT TREATMENT OF CAST STEEL
C Mn P S Si Cr Ni Mo
.32 .74 .038 .034 .36 2.80 .08 .42
PREHEATED TO 1000°F. HEATED WITH ONE BURNER 9" FROM CENTER OF 12" x 12" SEGMENT FACE, QUENCHED BY SINGLE SPRAY NOZZLE, ONE GALLON OF WATER PER MINUTE.

Figure 7—Sketch shows heating curves for steel segment during the face heating operation and the quench cycle.

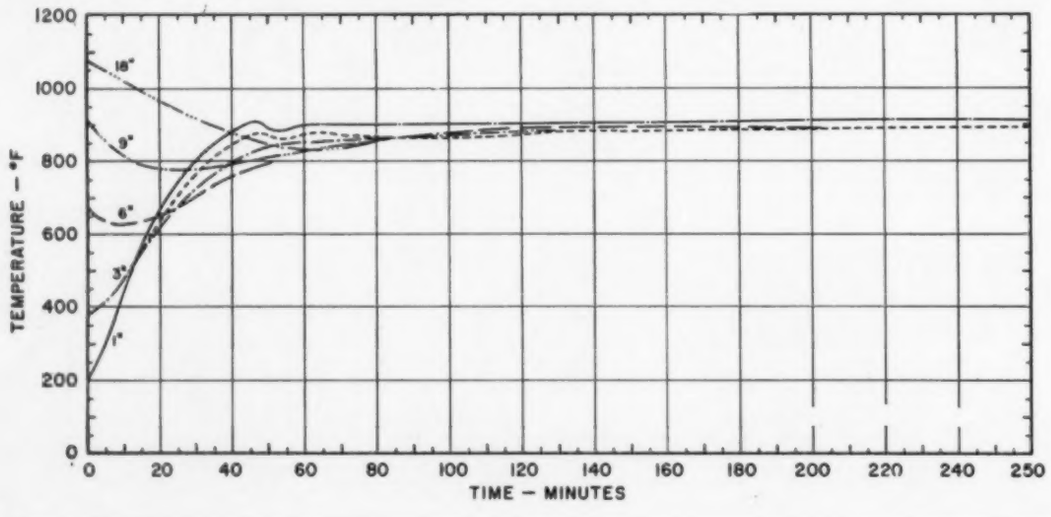


Figure 8—Curves show tempering cycle in heat treatment of steel segment.

The tempering cycle was also recorded, as shown on Figure 8. Zero time coincides with the end of the quench on the last chart.

So it can be seen that the challenge has been met and heat transfer by radiation was effective. It can be easily recognized, from the shape of the test piece, that the ultimate objective is heat treatment of steel mill rolls, and Figure 9 shows actual production equipment for heat processing of steel rolls up to sixty inches diameter.

Even though several such installations are in production, the test reported here was of recent date, because the potentialities of radiation effects and control are not explained in the average heat treating textbook, nor are the potentials fully understood or applied. One of the retarding reasons has been the widely held concept that a large piece of steel behaves differently than a small section, or to express it otherwise, the respect for size has overwhelmed and distorted some so-called "facts" which are largely based on misinterpretations.

Speaking of size Figure 10 shows surface heat processing equipment, constructed for plates and specifications as "fancy" as to depth, etc., as our roll specifications. And this equipment, furnished many years ago, is portable and also expandable to suit plate dimensions, as can be seen in Figure 11, wherein the three center panels are those of the previous picture. A single plate weighing 100 tons requires good sized equipment. No, size does not change the principles. though it might and does add problems and requires special consideration—and this observation or experience should be extended in both directions. Small parts also require and need heat transfer coordination with mass material and effect.

In general, large production and large masses are the pride of our production plants, and in the steel industry, the ingot is considered a steel processing stage, of a mass and cross section deserving special consideration. So let us devote our attention to the ingot—not a special kind—but average size, 19 x 23 x 78-in. long, weighing approximately 7800 lb, semi-killed steel of an average analysis of:

C	Mn	P	S	Si
0.16	0.56	0.014	0.046	0.06

Since our interest is one of gaining knowledge about obtainable heat transfer rates, temperature distribution, control requirements and of course effects upon rolling and the metallurgical soundness and structure, two conditions were investigated. Cold ingots were processed, and also hot ingots, the latter being charged into the heating furnace at periods ranging from five minutes to one hour after stripping, with approximately one hour lapsing between pouring and stripping. The difference in tracktime after stripping accounted for surface temperatures at charging time into the furnace, ranging from 1170 to 1560 F for the hot charged ingots. A total of thirty ingots were processed in this costly but highly interesting investigation.

Before presenting the results in brief, it might be well to familiarize you, through action photographs, with the heating furnace employed. Figure 12 shows hot ingot on furnace car ready for charging, and shows both furnace doors are open. Figure 13 shows furnace charged with ingot. Figure 14 shows furnace at end of heating cycle with ingot ready for discharge. Figure 15 shows hot ingot removed from furnace—ready for transfer to rolling mill.

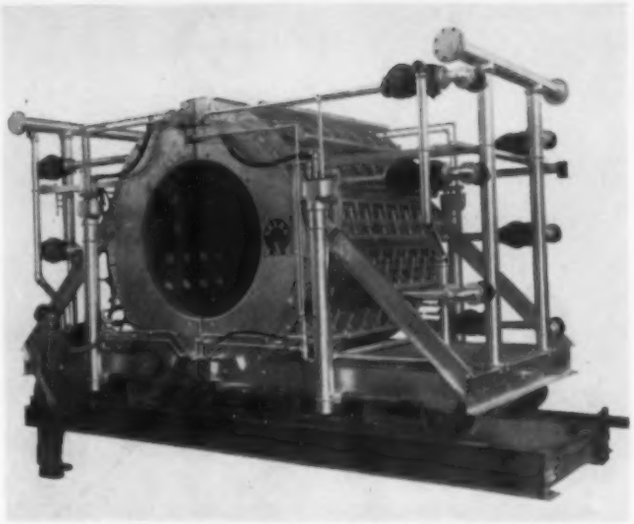


Figure 9 — Unit shown was designed to heat treat steel rolls up to 60-in. diam.

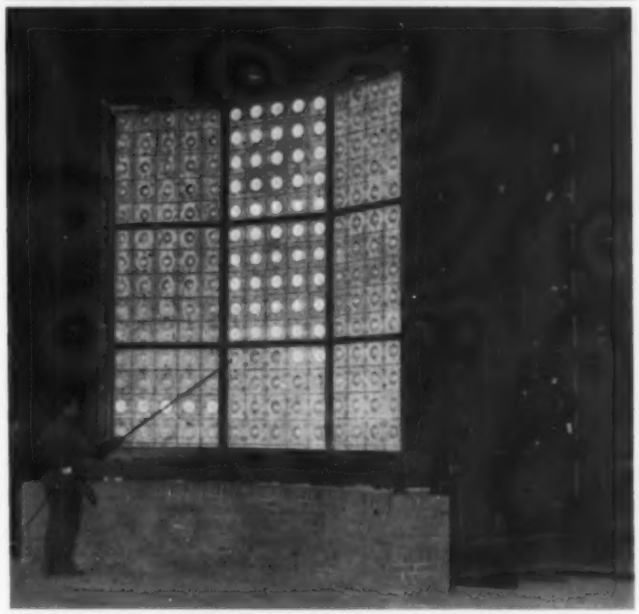


Figure 10 — Operator is checking burners on 3-panel radiant unit built for heat treating armor plate.

Figure 11 — Panel heating units are readily expandable for heat treating larger size units. Seven panels shown cover an area of 30 x 12 ft.

Figure 12 — Hot ingot on furnace car ready for charging.

Figure 13 — Ingot has now been charged into furnace.

Special attention is called to the fact that only the two furnace walls were equipped with burners, the doors carry no burners but have some flues to partially reduce the end losses. The ingots were therefore heated from two sides only. The cold ingots were equipped with thermocouples, one on the surface and one in the center.

Figure 16 gives the electronic potentiometer records of the heating-up cycle of three typical test runs. The top curve represents the furnace wall temperature;

Figure 14 — Ingot is shown at end of heating cycle.

Figure 15 — Ingot is shown discharged and is ready for rolling.

then come the recordings of the surface couples, and the low curves show readings of the center couples.

For better illustration of the significance of these tests, we might analyze Figure 17, which is typical of the average test. The furnace was idling at minimum heat input for the first ten minutes after charging of the ingot, as can readily be observed from the superimposed fuel input curve. This has been done to allow closing of furnace door, for connection of the thermocouples and all other detailed preparations for test readings. For the next thirty minutes, the furnace

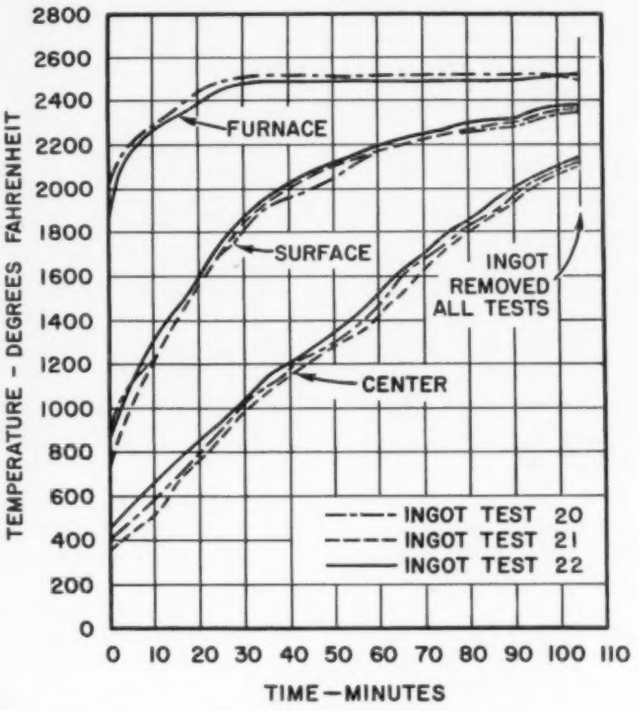


Figure 16 — Diagram shows heating curves for cold-charged 19 x 23 x 78-in. ingots weighing 7800 lb.

was operated at maximum fuel input and then throttled to allow soaking and avoid burning the surface—the fuel input regulation being performed by automatic control from surface temperature of the ingot. After 115 minutes from starting, the ingot was removed from the furnace and immediately rolled into 5 x 6-in. blooms in a reversing mill using approximately 23 passes—or the same number required for conventional soaking pit-heated ingots. The time from furnace car to first pass in rolling mill was timed at approximately sixty seconds.

These tests established a heating-up period of not more than 110 minutes for a cold charged ingot—although we rolled some after sixty minutes total furnace time—and a control requirement of fuel input in a ratio of at least twenty to one. Obviously a fundamental and important need for control of radiation is indicated considerably beyond conventional practice and equipment.

For hot charged ingots—having a surface temperature at charging time of 1250 F—the time required for heating and soaking was established at approximately forty minutes.

The finished rolled blooms were of course carefully checked for physical and metallurgical properties and, as can be expected, there are some differences in grain size and structure, as can be seen from Figure 18. On the left is shown microstructure of a four and one-half inch x six inch bloom rolled from an ingot heated in a conventional pit for six hours. On the right are the microstructures of a bloom heat processed from cold to rolling temperature for a drastic total cycle of only *one* hour.

At about 500 magnification (Figure 19) the difference is somewhat more apparent, but so far the significance of these differences has not been completely evaluated except that no detrimental effects have been detected. Power requirements for rolling have definitely not increased.

A true and final evaluation of such drastic departures from conventional practice is difficult. To some the differences seem insignificant, and the required practice of more effective utilization of heat transfers and temperature control is unjustified and unnecessary. Or, the argument may be that this is at best just another way of heating materials with fancier and more costly equipment and possibly more Btu's per pound, implying of course less efficient operation. It appears timely and important to challenge this approach or attitude because we cannot, as a technical economy and society, afford to neglect any manufacturing or production procedure, or any process or product improvement

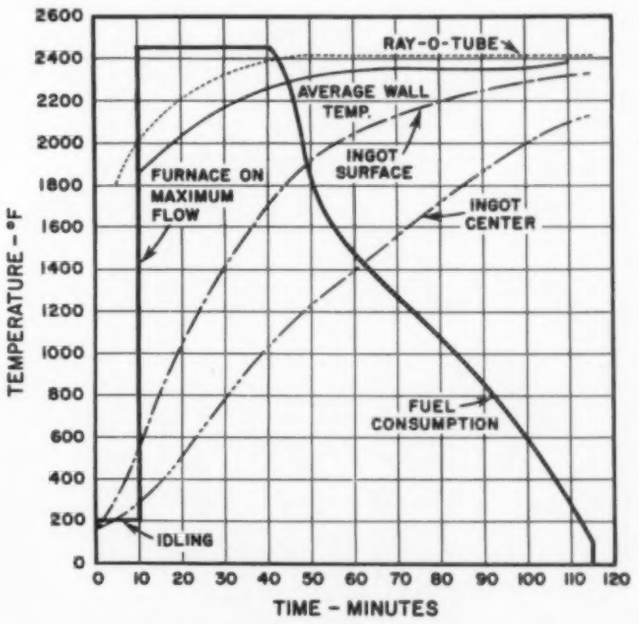


Figure 17 — Curve shows ingot temperature and fuel input rate vs time for 19 x 23 x 78-in. ingots.

which does affect our investments, our cost, operating results and world competitive position. The United States has been named the production plant of the world—and so it is—but so was England until it failed to adopt improvements and modernization over convenient conservatism.

There is already on hand sufficient evidence to justify thorough review and consideration, and the following will present a few examples.

For over a year, we have been press-forging shells at a metal temperature of 1840 F instead of the previous

standard of 2150 F. This is being done after direct heating, without descaling, without larger forging presses, with better die life, and with a metal saving approaching ten per cent because of scale and better concentricity. The physical properties of the finished forgings are superior to those of the hotter forging.

Experience with cold extrusion indicates that the typical coarse grained structure resulting from cooling from rolling temperature makes, for example, 1020 steel highly susceptible to cracking in the process. Normalizing seems required and would materially influence the availability of suitable steel supply. Six inch diameter 1020 steel heated to 1600 F in a total cycle of ten minutes showed these metallurgical results:

The effect on hardness is clearly evidenced by the Rockwell survey before and after heating shown in Figure 20. Even more significant are the micrographs of the grain structure which show a remarkable grain conversion in exceptionally short time—without soak.

This leads directly to another important subject deserving attention—scale loss as a factor of time and temperature. An extensive series of experiments developed some interesting and significant data, for which, two charts are introduced in this paper.

Figure 21 shows weight loss vs heating time in pounds per one hundred square inches of surface for 1020 steel, and when considering these curves it might be borne in mind that our previously mentioned normalized bar was subjected to only ten minutes total cycle up to 1600 F, which is well at the very beginning of these curves. If soaking time enters into the heating process, additional weight losses must be expected, as signified by Figure 22. Obviously these scale values must be added to those resulting during heating up.

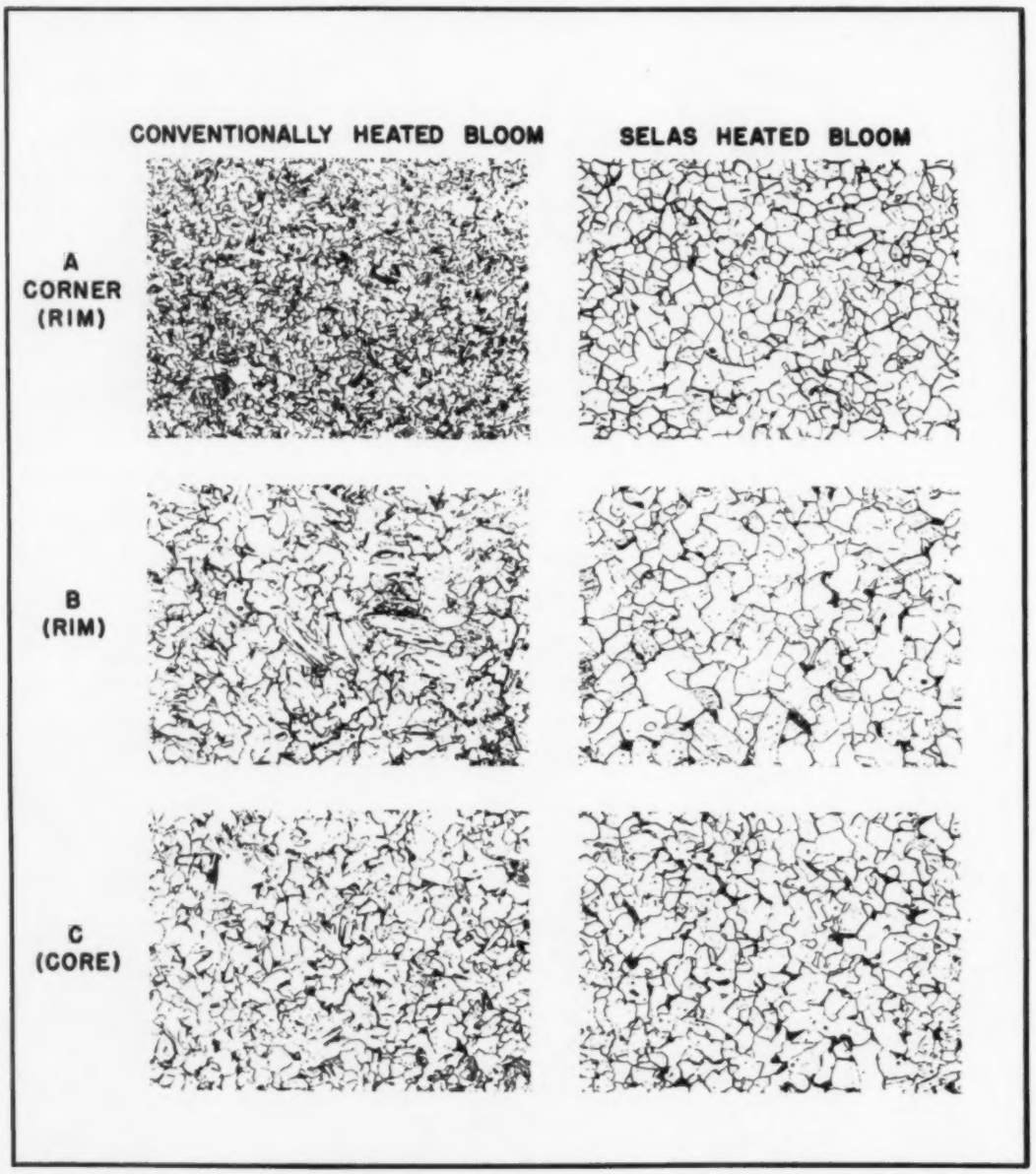
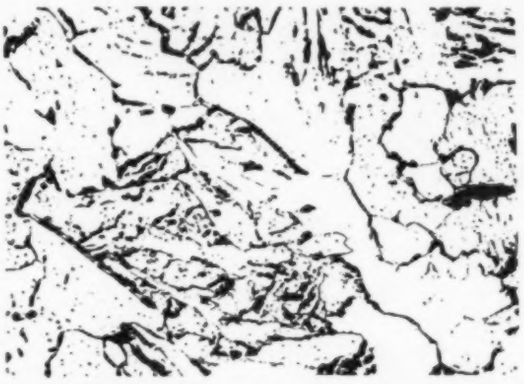


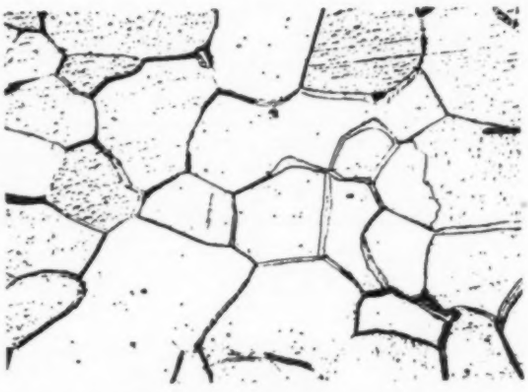
Figure 18 — Photographs show microstructure for conventionally heated blooms and blooms heated in a very short time. Magnification is 100 X.

One of the most striking examples of the effect and "mystery" of heat processing might well be the continuous bright annealing of strip steel. Figure 23 shows an installation which has been in operation for several years and which has now reached a production of 13,350 tons per month, representing an average speed of 850 fpm for 540 operating hours. It utilizes a direct fired heating unit at 32.9 per cent fuel efficiency for an eight-hour turn, and the total heating time of three seconds from cold to annealing temperature is insufficient to oxidize the surface of the tinplate stock. The

most significant fact, however, is that the product has improved metallurgical properties which are at present classified as universal temper, and shows also higher average corrosion resistance when compared with long cycle batch annealed coils. Thousands of tons have shown these product advantages, but so far the reasons for the differences have not as yet been conclusively established, although various theories exist. Somewhere our crystalline, or better our molecular structure is minutely different, and sufficiently so to result in different properties which we are able to notice and utilize. Can we, in the light of this, maintain that "in-



CONVENTIONALLY HEATED BLOOM



SELAS HEATED BLOOM

Figure 19 — Microstructure at corner (rim) for a conventionally heated and rapid heated bloom. Appearance of two is somewhat different. No detrimental rolling effects have been noticed.

significant" differences in processing are meaningless, or are they only insignificant to our casual observation, limited test and evaluation facilities? After all, the difference between a half life of fourteen billion years of thorium 232 and a half life of 23 minutes for thorium 233 is but one neutron, or a fraction of an atom. The same as one neutron is the difference between plutonium 94 and an atomic explosion. But we do not have to understand the science of atomic energy or the Einstein theory to comprehend the importance of minute differences of time and temperature and time at temperature upon the end product.

To make this clear beyond question let us depart from the steel industry and observe one of the oldest and most basic operations of one of its largest customers—the oil industry. Cracking of natural petroleum liquids or vapors by heating is one of the basic processes of the petroleum industry, and it has been performed in huge tubular heater structures comparable in size to the largest steel heating furnaces. Basically these heaters have been conceived as large combustion chambers for heat release to the fluid carrying tubes which were distributed along the walls, the floor and the roof of these brick lined structures. Heat is transferred to the tubes mainly by radiation and convection, and to the fluid inside the tube by conduction. Any one familiar with this thermal cracking process, such as the steel and alloy tube industry, knows the influence of heating rate and hot spots, etc., upon tube life, coking, and also knows the general specification limiting heat transfer per square foot of tube surface. But to make our story clear, and bring out the implications for the steel industry specifically, and for heat processing in general, it appears necessary to be explicit with the following facts and figures.

Let us consider some of the factors involved in the design of any tubular heat processing furnace:

1. For a fixed flow rate, tube size must be selected to obtain a reasonable fluid velocity and pressure drop.
2. Based on properties of the material flowing and the mass velocity, a fluid film coefficient must be calculated.
3. Allowable flux densities must be calculated based on the above fluid film coefficient, which will result in a safe operating fluid film temperature, that is, a temperature above which excessive reaction or decomposition will occur.
4. For this allowable rate, the temperature at the outside face of the tube may be calcuated. This temperature and operating pressure are taken into account in the selection of tube materials for the heating coil.

With a single row of tubes installed along the furnace wall and spaced on the tube centers equal to twice the tube diameters, the tubes are heated from one side by direct radiant heat, and from the other side by reradiation from the refractory wall. The total direct radiant heat absorption by the tubes is 65.8 per cent of the total radiant heat released, while the absorption by reradiation from the hot refractories amounts to 22.5 per cent of the total radiant heat released. This relationship is based on the assumption that all of the radiant heat which falls on a furnace refractory is reradiated to the tubes, whereas actually a small amount is lost by conduction through the refractory wall. A flux distribution, such as that shown on Figure 24 will occur, with the rate on the fire side being equal to three times that on the refractory side, and the average rate will be 56.2 per cent of the maximum rate. Thus by far the greatest amount of heat will be transferred through one side of the furnace tubes, with a much smaller amount of heat moving through the furnace wall side.

From the foregoing it is apparent that design of a heater employing wall tubes must be based on conditions that exist on the fire side where most severe conditions prevail. If, for example, a maximum rate of

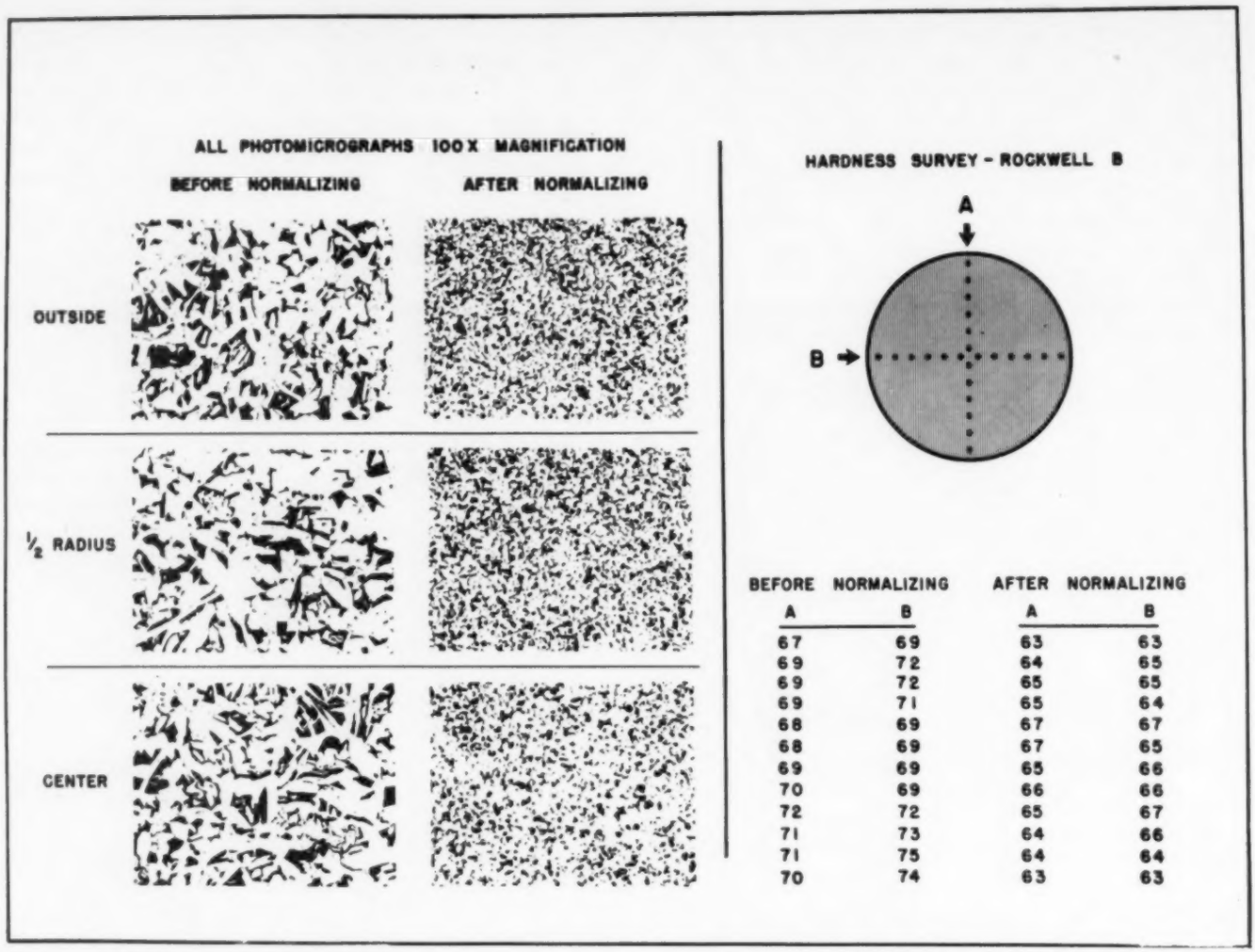


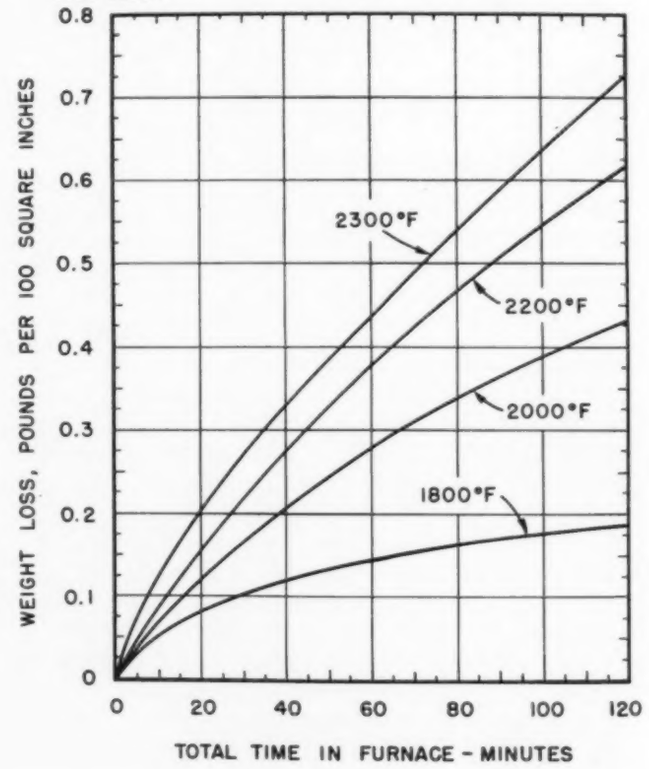
Figure 20 — Hardness and appearance is shown for this 6-in. diam, hot rolled SAE 1020 bar steel for cold extrusion.

15,000 Btu's per hour per square foot is determined to be allowable, this rate must be set up on the fire side, while only about 5000 Btu's per hour per square foot will be developed on the refractory side. The resulting average will be about 8430 Btu's per hour per square foot.

When the furnace structure is rearranged so that heat can be applied to the tubes from both sides directly, heat distribution is developed according to the pattern in Figure 25, and the average will be 87 per cent of the maximum rate. If, as in the previous hypothetical case, the maximum allowable rate is 15,000 Btu's per hour per square foot from maximum film temperature considerations, the overall average will be effectively increased to 13,050 Btu's per hour per square foot without exceeding specified limitation. Thus, the duty has been increased almost fifty-five per cent per square foot of exposed radiant surface. Moreover, the large differences in the tube wall temperature that exist with unequal application of heat, have been eliminated, thereby minimizing the extent to which uneven stresses are set up on the two halves of the tube.

As stated, these are hypothetical examples as far as Btu per square foot are concerned, although for most operations, 10,000 Btu's were considered maximum allowable heat transfer per square foot for conventional heaters. What it does mean to us, and in practice, can be seen from Figure 26, which shows a comparison

Figure 21 — Curves show weight loss vs heating time for 1020 steel.



of operating results from a heater with high radiant heat input from both sides compared with a conventional wall tube heater, both charging the same material, namely: catalytic recycle oil. The lower coil outlet temperature on the box type furnace of 920 F is explained as the maximum temperature which could be reached without excessive coil coking. It is otherwise evident that higher yields of the desired end products of the operation were obtained, and the difference in octane rating can represent millions of pounds of lead —or cheaper gas of higher octane rating.

On a thermal efficiency test operating conditions were recorded by a major refiner as shown on the table in Figure 27. It will be noted that an overall thermal efficiency of 81.5 per cent was realized, and that 75.3 per cent of the total heat transferred occurred in the radiant section fired from both sides—the balance in the heat exchange tubes above the firing section. Notice also that the average Btu per square foot has been 17,000 Btu's, and it is noteworthy that operations are being performed successfully with rates as high as 30,000 to 40,000 Btu's per square foot. Further work in the petrochemical industry is proceeding rapidly, and existing limitations are expected to be overcome once the tube industry can cope with the requirements for higher temperatures and pressures. In fluid heat processing, we are dealing with heat and pressure conversions where a fraction of a second at temperature can mean successful operation or process failure. The results are clear beyond doubt, because the end product and its properties are recognizable and the yield is often of critical importance. A mere change in the heating curve, that is the time relationship between coming up to temperature and holding at temperature—all within seconds—makes the difference between 54 per cent yield and 78 per cent yield.

Simultaneously continuous operating periods, without shutdowns due to coking, are extended from three days to more than forty days, or 1300 per cent, by an "insignificant" change in processing time-temperature cycle.

Figure 22 — Curve shows weight loss vs holding time for 1020 steel.

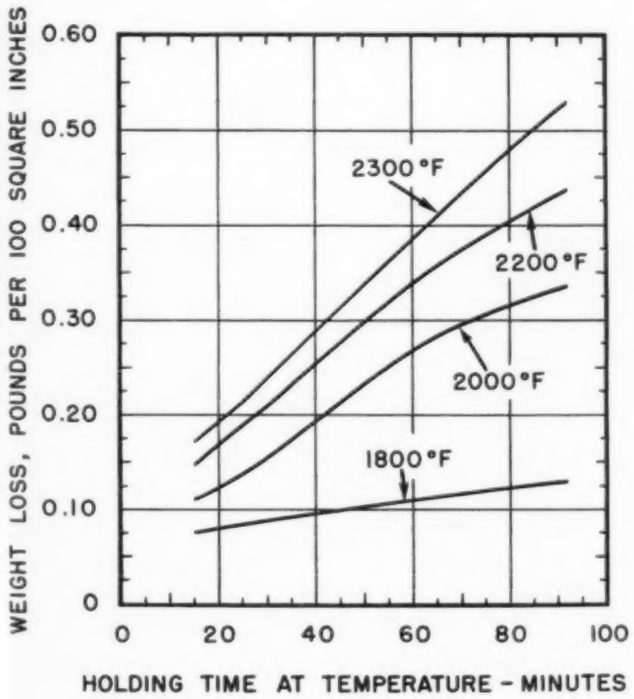
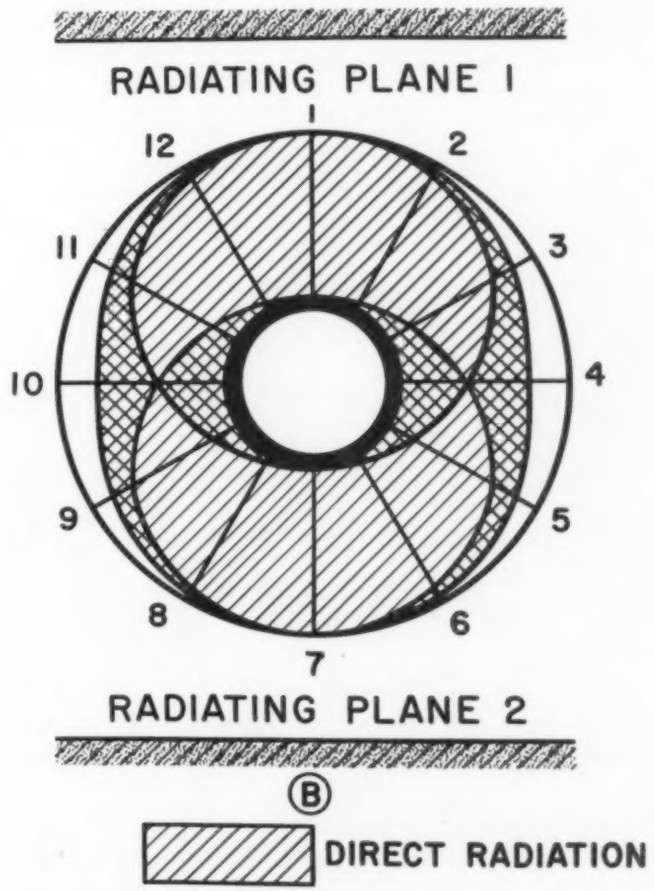


Figure 23 — Continuous bright annealing of strip steel is one application of rapid heat treatment adopted by the steel industry.

Figure 24 — With tube design shown, heat distribution is uneven as shown by sketch for flux distribution.



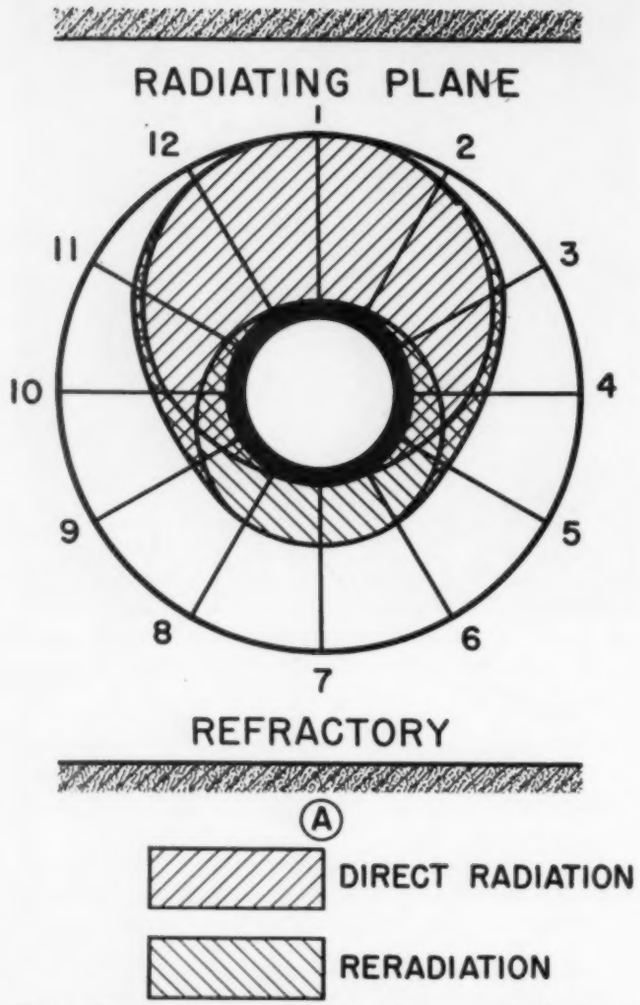


Figure 25 — Better and more even heat transfer is shown by this flux distribution.

Why does this example deserve attention by steelmakers and within the scope of this paper? It is not only because tube and tube quality is of importance, and radiant heat transfer operates at its best or because the process is termed thermal cracking, and thereby very descriptive. No, we are concluding this presentation with this example because it illustrates, beyond question, that heat processing is basically a "pushing around" of molecules or atoms or other minute physical designations and particles, and we can do it effectively and drastically in fractions of a second and under controlled conditions. And are not metals, is not all matter made up of similar particles, in different arrangements and composition, and let us say, cohesions. The answer is "Yes," but is it not justifiable to conclude that important—but so far unknown—variations and effects are or can be produced by minute variations of the heat processing cycle, or temperature changes or atmosphere changes? In that connection I should like to refer to a book by M. W. Thring, head of the Physics Department of the British Iron and Steel Research Association. It bears the title "The Science of Flames and Furnaces," and was published in 1952. The book was written, and I quote: "In the hope of assisting to raise the industrial furnace from the status of Cinderella before the arrival of the Fairy Godmother. The furnace of the future will be a precision tool of the highest accuracy and reliability controlled by instruments as good as those in an aircraft, and with every process within it as thoroughly studied as the circuit of a wireless set."

	Radiant	Box Furnace	
Coil Outlet, Temperature F	1025	920	
Pressure, psig	700	1100	
Charge rate, bbls/hr.	100	300	
Aniline Point Reduction F	50	35	
Yields, LV Percent of Charge:			
Gasoline	30	22	
Gas Oil	44	57	
Fuel Oil	10	12	
Conversion of Gas Oil to Other Products, Liquid Volume Percent of Charge:			Difference
Gas	28.6	20.9	+7.7
Gasoline	53.4	51.1	+2.3
Fuel Oil	18.0	28.0	−10.0
	100.0	100.0	
Gasoline Octane Number:			
F-1 Clear	73	66	
+ 3cc TEL*/gal.	86	80	

* Tetraethyl Lead

Figure 26 — Table gives comparison of result in thermal cracking a cycle oil in a radiant type and box furnace.

	Top	Bottom
Firebox Temperatures:		
Maximum	1490	1580
Minimum	1390	1575
Average	1425	1580
Stack Temperature	712	
Coil Temperatures:		
Inlet	117 F @ 790 psig	
Outlet	1020 F @ 500 psig	
Fuel Gas Fired	39,400 CF/Hr.	
Heat Balance:		
Heat released by flame	32.6×10^6 BTU/Hr.	
Heat pickup by oil in furnace	29.5×10^6 BTU/Hr.	
Overall efficiency (Net Heating Value)	81.3%	
Heat pickup by oil in radiant section	22.2×10^6 BTU/Hr.	
Average radiant heat transfer rate	17,000 BTU/Hr. per sq. ft.	
Percent of useful heat	75.3%	
Heat pickup by oil in convection bank	7.28×10^6 BTU/Hr.	
Average convection heat transfer rate	4,920 BTU/Hr. per sq. ft.	
Percent of useful heat	24.7%	

Figure 27 — Thermal efficiency test data for a radiant furnace.

Such thinking and projection seems warranted by our many unexplained behaviors and observations and results—but at any rate it should benefit our studious search for additional knowledge and understanding of heat processing—our continuous exploration for more facts and figures.

DISCUSSION

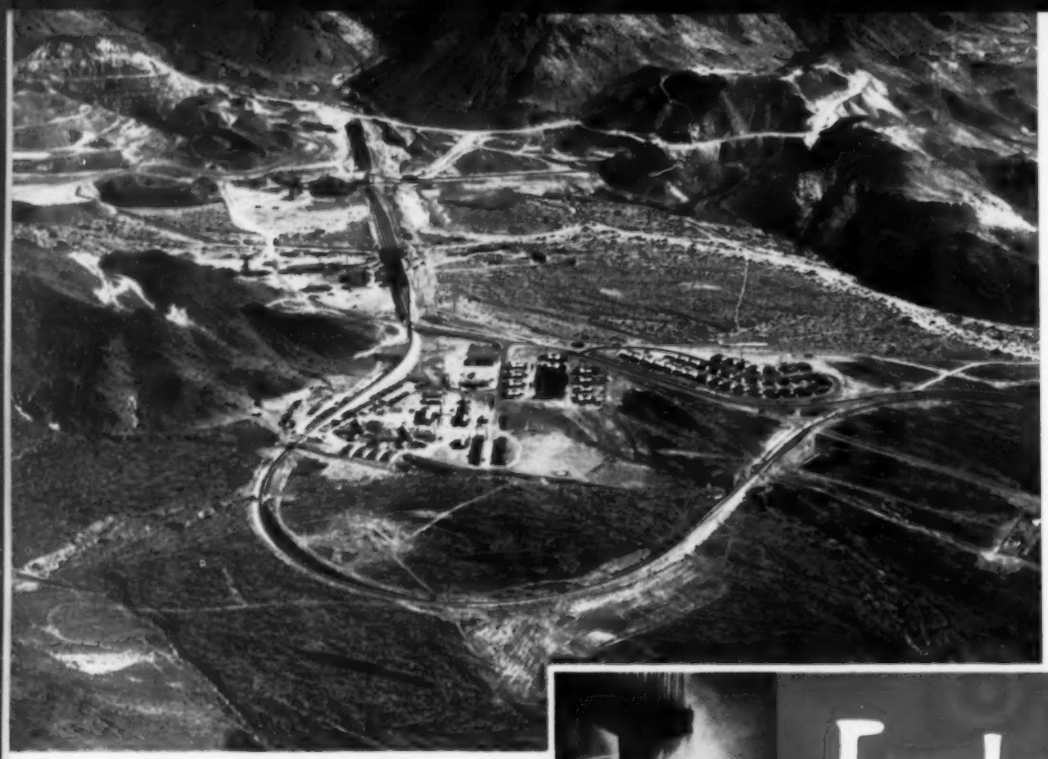
PRESENTED BY

A. F. KRITSCHER, Assistant Chief Engineer Process Development, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

A. F. Kritscher: We have had some experience with these high-speed heating rates in our company. These rates are attainable and the uniformity obtained is very good. It should be pointed out that it is almost impossible to uniformly heat to high temperatures at high rates without completely exposing the material.

KAISER STEEL CORPORATION'S

Fontana Plant



Eagle Mountain ore mine.

KAISER STEEL CORPORATION'S

Fontana Plant

by T. J. Ess

. . . . originally noted for the speed of its construction, the Kaiser steel plant must also be recognized for its subsequent rate of expansion, making it one of the most diversified steel plants in the country . . . .

▲ COMPARISON of today's Fontana plant with the original plant presents a striking contrast.

When the Iron and Steel Engineer was privileged to publish a description of Fontana in 1945 (AISE Annual Proceedings, 1945), there was capacity for 368,000 tons of coke, 438,000 tons of iron, and 1,028,000 tons of steel ingots per year. Today, Fontana has annual capacities of 1,006,000 net tons of coke, 1,314,000 net tons of iron, and 1,536,000 net tons of ingots. In addition, rolling and finishing facilities have been installed which have resulted in greater diversity of products as well.

The history of the plant shows a constant program of construction, with one or more major products every year, reflecting the restless energy of its founder, Henry J. Kaiser, and his organization. Today's Fontana has refuted the pessimistic predictions of ten years ago. The "steel plant in an orange grove" has come to stay.

The Fontana plant, located on an 1800-acre site in the San Bernardino valley about 45 miles east of Los Angeles and employing approximately 6900 people, has taken its place as an important unit in the steel industry of the United States. Many of its operating practices have set patterns from which the steel industry in general has profited. Its products are helping in the development of western industry.

RAW MATERIALS

All iron ore for the Fontana plant comes from the company's Eagle Mountain mine, 163 miles from the steel plant. Ore reserves, a combination of magnetite and hematite, have been proved for 25 years operation of three blast furnaces. At present, two ore bodies are being worked which will be mined in one pit, using 20 benches, each 30 ft high. After drilling and blasting, four electric shovels load the ore into 21 trucks of 10 to 15-cu yd capacity. A primary crusher breaks up the ore to –10 in. This equipment produces an average of more than 13,000 tons of ore per turn.

A new beneficiation plant, designed to handle 700 tons per hr, further crushes the ore to –1 in., and screens it into three sizes: 0 x ¼ in., ¼ x ½ in. and ½ x 1 in. The two larger sizes are put through magnetic separation and the non-magnetic portion through heavy

media separation. The concentrates from these processes run more than 62 per cent iron.

Thus, three types of ore (–1 in. unbeneficiated, ¼ x 1 in. beneficiated, and –¼ in. unbeneficiated) are produced and shipped daily in quantities as required by blast furnace requirements. Each grade is taken from its separate stockpile and conveyed through an underground tunnel to a railroad car loading bin. A 51-mile standard gage railroad connects the mine with a main line of the Southern Pacific Railroad.

Analysis of the ore shipped is about as follows:

	Per cent
Fe	55-56
P	0.08-0.09
SiO_2	9-10
Al_2O_3	1.0-1.5
CaO	1.0-2.0
MgO	3.5-4.0
S	0.3-0.4

At the steel plant, cars are unloaded by a rotary car dumper and the ore is handled by belt conveyors and stackers on to six stockpiles 555 ft long x 55 ft wide. The ore is taken from these beds by a rake reclaimer and conveyed by belts to the blast furnace stock bins. The fine ore is taken to the stock bins of the sintering plant.

Limestone, sized 3 x ½ in., is purchased from an outside quarry. Received in railroad cars, the stone is unloaded into a track hopper and handled by conveyors either to a stockpile or to the blast furnace bins.

Coal comes principally from the company owned Sunnyside mines in Carbon County, Utah, approximately 800 miles from Fontana. The coal is crushed to –6 in. and screened to –4 in., then blended in a 16-cell 4,000-ton bin. The –6 in. coal is washed in two six cell jigs, dewatered and loaded in railroad cars. The washing process reduces the ash from 20 to 7.9 per cent and the sulphur from 1.50 to 1.30 per cent.

Since this coal is weakly coking, it is necessary to mix 10 to 15 per cent of low volatile coal with it to obtain a coke that will give satisfactory blast furnace operation. This low volatile is purchased from mines in Arkansas and Oklahoma. It is not washed, but is hand-picked free of rock and slate and screened to give a –2½-in. size.

Analysis of the coals run about as follows:

	High volatile coal, per cent	Low volatile coal, per cent
Moisture	6.0	4.0
Ash	7.9	7.4
Volatile matter	40.5	17.7
Fixed carbon	51.6	74.9
Sulphur	1.30	0.87

COKE OVENS

Coking capacity has been increased by the addition of three new 45-oven batteries, placed end to end in line with the two original batteries. The new ovens, essentially duplicates of the older units, are of underjet, low-differential type, 13 in. and 15½ in. wide x 40 ft 5½ in. long, inside of doors, x 13 ft high. With a 12-ft coal line, each oven has a volume of 576 cu ft which, with a bulk density of 50 lb per cu ft, gives a coal charge of 14.4 tons per oven.

The ovens are regenerative and designed to use either coke oven gas or blast furnace gas, with recirculation of hot waste gases when coke oven gas is used. The gas is burned in 28 vertical flues spaced across each oven wall. Vertical flues unite in groups of four into collecting flues, and cross-over flues connect each collecting flue in an oven wall with corresponding flues in the opposite wall.

Coal arrives at Fontana by rail and is unloaded by a rotary dumper into a track hopper, from where it is taken to storage piles by belt conveyor and a stocking machine. All coal is put into stock, spread, rolled and packed by bulldozer, so as to minimize the variation in coal quality as it comes from the mines, and prevent oxidation. The average time coal is allowed in storage is 60 days.

Coal is removed from storage by clam shell buckets and conveyed by belt to two breakers, where it is sized to –1¾ in. Coal is then taken to four 150-ton mixing bins, two of which hold high volatile coal and two, low volatile coal. Gates under the bins are set to discharge the different coals in the desired proportions into two hammer mills, which are adjusted to pulverize the coal so that 65 to 70 per cent will pass through

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At Fontana, iron ore is handled by conveyors and stackers on to six stockpiles.

⅛-in. mesh screen. From the hammer-mills, the coal mixture is conveyed to two oven storage bins, each of 1800 tons capacity.

All of the oven machinery is of conventional type. Pusher machines and door machines are equipped for hydraulic latching of oven doors. Two quenching cars, moved by electric locomotives, carry the coke to two towers where it is quenched with waste liquor from the by-product plant.

The coke handling system consists of two wharfs from which coke is taken by conveyor belts directly to three 1200-ton storage bins, one at each of the three blast furnaces.

Gas leaving the ovens flows through four direct-type primary coolers under the action of four 19,800-cfm turbo exhausters. Five electrostatic precipitators, placed after the exhausters, clean the gas. Tar is recovered in five decanter tanks, and subsequently dehydrated to less than 2 per cent moisture. It is then pumped to a commercial tar distillation plant nearby.

The gas next flows through a spray type stainless steel ammonia absorber where sulphuric acid combines with the ammonia in the gas to form ammonium sulphate. The ammonium removal system consists of two absorbers, one being a spare. The new unit has a vacuum crystallizer for control of the crystal size.

Ammonium sulphate slurry from the absorbers may be processed in either of two drying systems. One consists of two centrifuges which remove sulphate liquor, and discharges the salt into hot air conveying system which further dries it, while blowing it to cyclone feeders from where it drops onto the storage pile. The other is a top-feed filter in which both sulphate liquor and moisture are removed.

Additional ammonia is recovered from the surplus gas liquor in a bubble-cap still, and the ammonia is either put back into the gas stream ahead of the primary coolers, or used for neutralizing mother liquor in the pyridine recovery plant.

Phenol is removed from the surplus liquor in a dephenolizing tower and recovered as sodium phenolate, which is then processed in a springing plant where the crude phenol is released by the reaction of CO_2 in waste gas from the stack flue.

After the ammonia absorbers, the gas passes through final coolers and then through six direct-type scrubbers, where wash oil absorbs the light oils.

The light oils are then steam-stripped from the wash oil and separated by rectification into two fractions, secondary light oil, made up of benzol, toluol and xylol, and intermediate light oil, containing the heavier solvent fractions. These fractions are further refined in the complete benzol plant which has been enlarged to take care of the coking expansion.

Based on the fastest schedule, with a gross coking time of 16.36 hr, 330 ovens may be pushed per day, carbonizing 4700 tons per day. With this schedule, flue temperatures run about 2350 F.

Furnace coke yield averages 62 per cent, and breeze, 5 per cent. By-product yields per ton of coal carbonized run about as follows:

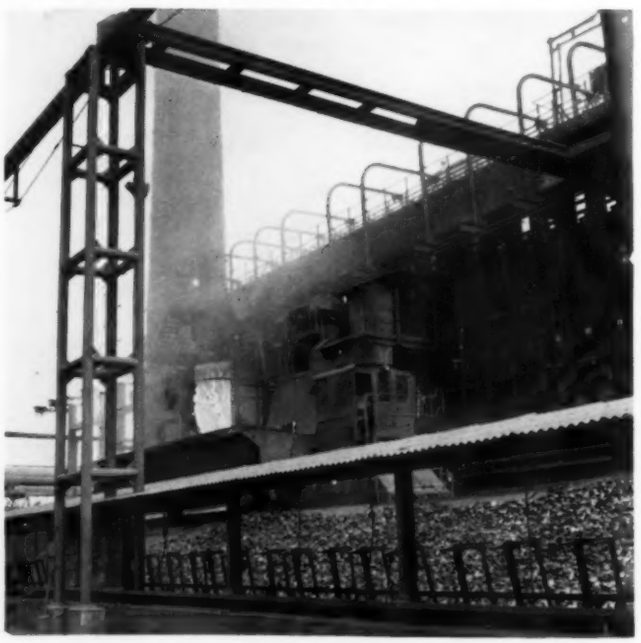
Coke oven gas	11,600 cu ft
Tar	10 gal
Ammonium sulphate	25 lb
Light oils	3.6 gal
Phenol	0.05 gal
Pyridine	0.02 gal

Since all ovens are normally heated with blast furnace gas, all of the coke oven gas is surplus and is used in the steel plant. A 50,000-cu ft gas holder regulates the gas flow to three turbo-blowers, each rated at 22,900 cfm, which boost the gas pressure up to 6 psi for distribution to the steel plant and boiler house.

BLAST FURNACES

To the initial blast furnace have been added two more, one starting in 1949, and the other in 1953. The

Coke ovens are of underjet, low-differential type, designed for coke oven gas or blast furnace gas heating.



The coke plant now has 225 ovens, capable of carbonizing up to 4700 tons of coal per day.

three furnaces are essentially duplicates, with details as shown in Table I. The hearths are cooled by cast iron staves, with copper cooling plates in the bosh and up into the stack, 22 ft above the mantle. The stockline is protected by cast steel wearing plates.

Gas, at about 350 F, leaves the furnace through four unlined off-takes 6 ft 1½ in. in diameter, which combine into two 7-ft down-comers. On each furnace the gas passes through a 29 ft x 38 ft dust catcher, a 20 ft x 50 ft tower washer and two 22 ft 6 in. x 22 ft 11 in. electrical precipitators. Dust content in the gas ranges 0.05-0.08 grains per cu ft after the wet washer, and 0.002-0.005 after the precipitators. About 35 per cent of the gas is used in the blast furnace stoves, with the surplus going to heat coke ovens and to boiler fuel. A waterless type gas holder of 1,000,000-cu ft capacity provides some storage to carry through brief furnace delays.

Three 90-ft settling basins receive the water from the gas washers and precipitators. Sludge from these thickeners is discarded.

The furnaces are charged by conventional double skips with 200-cu ft cars dumping into revolving distributor tops, all under automatic control. Large and small bells are actuated by pneumatic cylinders operating on cold blast. The charging sequence is normally ore, stone, ore/coke, coke, coke, coke. The average burden for basic iron is approximately as follows:

	Lb per charge
Eagle Mountain ore	16,400
Eagle Mountain sinter	20,400
Roll scale	1,000
Coke	16,000
Limestone	5,400
Open hearth slag	3,000

Coke, ore and stone are all charged by weight.

Coke is screened over a ⅝ in. screen just before loading into the furnace skip. The –⅝ in. coke is rescreened into ⅜ x ⅝ in. nut coke and –⅜ in. breeze. The breeze

TABLE I

BLAST FURNACE DIMENSIONS

Diameter of hearth, ft-in.	25-6
Diameter of bosh, ft-in.	28-3
Diameter of stockline, ft-in.	19-6
Height, iron notch to top ring, ft-in.	97-6
Height of crucible, ft-in.	12-6
Height of bosh, ft-in.	11-9
Height of straight section, ft-in.	7-6
Height of inwall section, ft-in.	54-0
Height, stockline section to top ring, ft-in.	14-0
Height, bottom to iron notch, ft-in.	2-3
Height, iron notch to cinder notch, ft-in.	4-8
Height, cinder notch to tuyeres	3-4
Working volume, tuyeres to stockline, cu ft	42,600
Bosh angle, deg-min-sec	83-19-32
Inwall slope, in. per ft	0.972
No. of tuyeres	16
No. of columns	8
Lining thickness, crucible, in.	36
Lining thickness, bosh, ft-in.	31-½
Lining thickness, stack, ft-in.	42
Lining thickness, throat, ft-in.	42
Big bell diameter, ft-in.	15-0
Big bell angle, deg	50

is consumed at the sintering plant, while the nut coke is sold commercially.

Blast is provided to the three furnaces by four turbo-blowers, two rated at 100,000 cfm, two at 75,000 cfm, each equipped with a surface condenser. Electrostatic precipitators are installed in the intakes to the blowers to prevent cutting of the rotors by sand carried by prevailing winds. Steam is added to the blast to maintain a moisture content of 5 grains per cu ft. Blast volume normally ranges 65,000-70,000 cfm.

Each furnace is provided with three two-pass, side-combustion stoves, 25 ft in diameter. Gas is burned through proportioning pressure type burners. On No. 1 furnace, the stoves are 114 ft 6 in. high and contain 141,000 sq ft of heating surface. The stoves for No. 3 furnace are 99 ft 5 in. high and each contains 183,170 sq ft of surface. Stoves are changed every two hours, and blast temperature, which averages about 1200 F, is automatically controlled.

Iron production is preponderantly of basic type, with analyses ranging as follows:

	Per cent
Silicon	0.90-1.25
Sulphur	0.03-0.04
Phosphorus	0.15-0.30
Manganese	0.30-0.40

The iron is used as hot metal in the open hearth and in the foundry, and is sold as merchant pig iron.

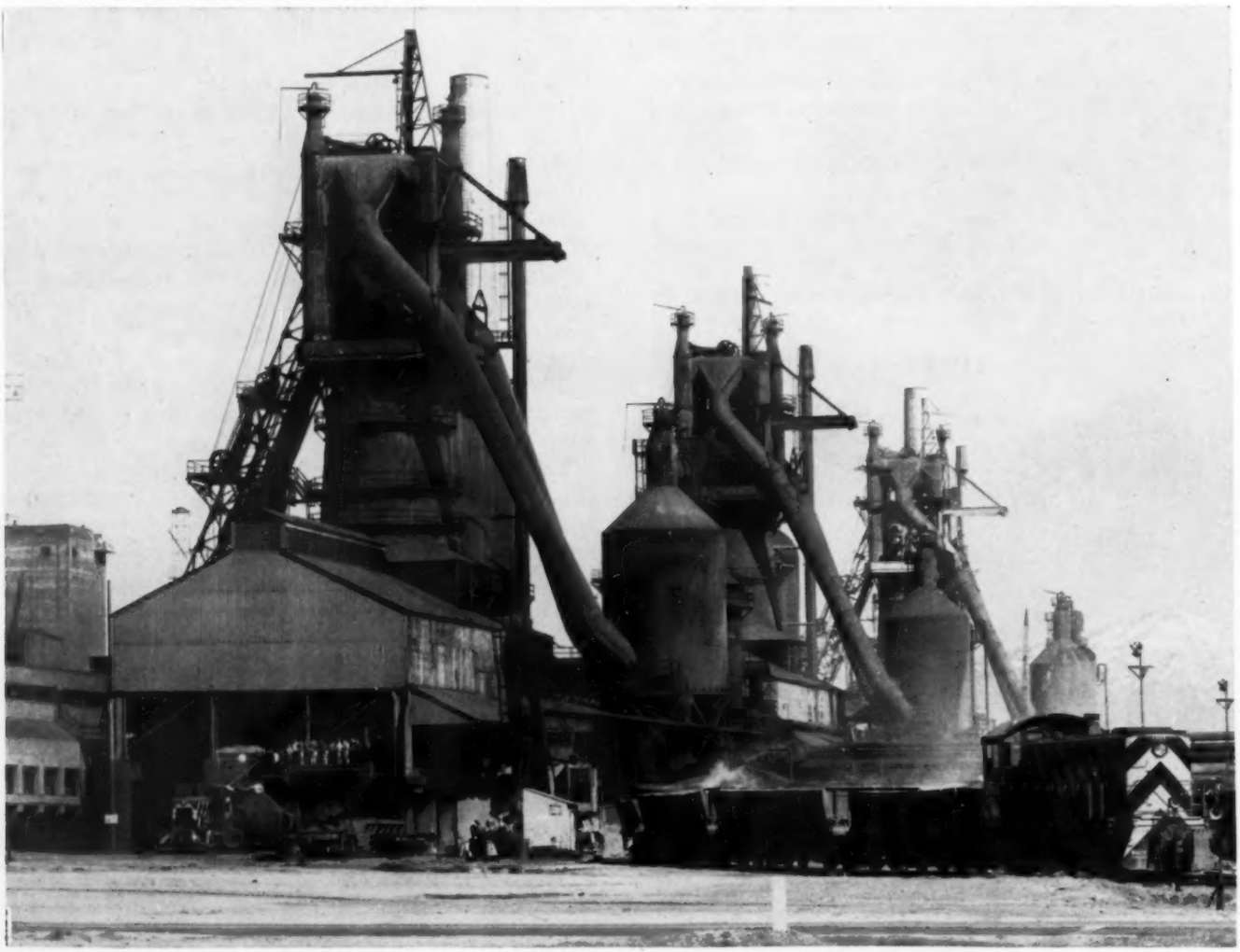
The furnaces are cast every 4.8 hr, the iron flowing into 150-ton mixer type ladles which are then moved to the open hearth or to a double strand pig machine. This machine, 168-ft long, can cast 100 tons per hr into 50-lb pigs. Daily production of each furnace averages 1300-1365 net tons per day. Coke consumption averages 1400 lb per net ton of iron produced. Limestone consumption runs 400-600 lb per net ton of iron. Slag, ranging 900-1200 lb per net ton, flows into dry pits from which it is dug out by power shovels. Slag analysis runs about as follows:

	Per cent
SiO_2	35.00
Al_2O_3	12.00
CaO	40.00
MgO	10.00
S	1.50-1.80
Fe	0.35
Mn	0.25

Flue dust averages about 80 lb per net ton of iron.

Two traveling-grate sintering machines provide capacity for 3000 tons of sinter per day. Each machine is 72 in. wide x 102 ft long and contains 16 wind boxes. All of the 0 x ¼ in. ore from the mine, as well as some

Three blast furnaces, with 25 ft 6 in. hearths, provide an annual capacity of 1,314,000 net tons of iron.



Annual steel making capacity has been expanded to 1,536,000 net tons of ingots. There are nine open hearth furnaces.

of the ¼ x ½ in. magnetic ore, is mixed with flue dust and coke breeze and sintered in these machines.

OPEN HEARTH

Steel producing facilities at Fontana have been expanded by the addition of three open hearth furnaces, making a present total of nine. The six original furnaces, rated at 185 tons, were described in detail in the previous article on this plant. The three new furnaces, which are rated as 200 ton units and are to serve as the pattern for future rebuilds of the older furnaces, have an overall length of 81 ft 9 in., with hearth dimensions of 17 ft 3 in. x 53 ft 9 in.

The furnace hearth, totaling 36 in. in thickness, consists of 2 in. of insulating concrete, 9 in. of first quality firebrick, 9 in. of burned chrome brick, and 16 in. of basic ramming mix. The back wall is of sloping construction, and the sprung arch roof, 18 in. thick with 24-in. ribs every fourth course, has a rise of 3 ft 5 in. in its span of 20 ft 10½ in. The longitudinal profile of the roof shows a horizontal length of 8 ft 5⅞ in. over the downtakes, then a drop of about 39 in. in the next 7 ft 0⅞ in., another horizontal length of 6 ft 0¾ in., a rise of 4⅛ in. in the next 5 ft 1 in. of length, and then a horizontal run of 14 ft 2 in. to the center of the furnace.

The furnace throats, with a width of 15 ft 6 in., are only slightly constricted. Each downtake is 6 ft 6 in. long x 5 ft 2 in. Slag pockets are 15 ft 10½ in. x 18 ft.

Regenerator chambers 33 ft 9 in. x 21 ft 9 in. are of single construction with a sprung arch roof 13½ in. thick. Each chamber contains checker work 29 ft 9 in. long x 17 ft 9 in. wide x 15 ft high, giving a checkerwork volume of 8100 cu ft on each end of the furnace. The chambers are covered above ground with insulating block topped by insulating cement.

Flues 5 ft 6 in. x 6 ft 6 in. lead from each regenerator chamber to a stack flue which connects to a reinforced concrete stack 175 ft high.

The furnaces are fired entirely with fuel oil, which is received in tank cars and unloaded by reciprocating steam pump into two storage tanks of 1,500,000 and 750,000-gal capacity, respectively. Oil in these tanks is maintained at a temperature of about 150 F. Line heaters in the pump room raise the temperature to 180 F, while individual heaters at each furnace are automatically controlled to give a final oil temperature of 200-220 F.

Air is supplied to each furnace by a forced draft fan rated at 18,000 cfm, 4-in. water column. Furnace pressure is automatically controlled at about +0.07-in. water column. Recording and indicating instruments are provided for furnace pressure, air flow, oil temperature and oil flow. Indicating pressure gages are applied to oil and steam lines, and checker flue temperature is recorded.

Seven waste heat boilers are installed, two of 7800 sq ft and five of 13,000 sq ft heating surface.

Furnace charges consist of about one-third scrap and two-thirds hot metal. The iron comes to the open hearth in 150-ton mixer type ladles and is poured into 90-ton ladles which may then be taken directly to a furnace or emptied into either of two 800-ton mixers, one at each end of the open hearth shop.

For deoxidizing, aluminum, silicon, and manganese are used separately or in combination, as may be required by the type of steel being produced. Miscellaneous material consumption run about as follows:

Steel, produced in almost every standard open hearth grade, is poured into a variety of ingot molds.

	Lb per net ton of ingots
Fluxes	130
Ferroalloys	21
Deoxidizers	1
Iron ore	153

The furnaces turn out heats of about 223 net tons in about 10.2 hr, tap-to-tap, averaging approximately 22 tons per furnace hour. Fuel consumption averages approximately 2,800,000 Btu per net ton of ingots produced.

Steel is produced in almost every standard open hearth grade. It is poured into slab ingots 26 in. x 34 in., 26 in. x 42 in., and 30 in. x 42 in.; bottle top slab ingots 25 in x 38 in., and 26 in. x 42 in.; and 23 in. x 25 in. ingots for the production of blooms. Ingot molds are sprayed with a solution of 100 lb of graphite in 50 gal of water.

The furnaces are designed for front and back flushing. Flush slag flows into a cinder pot carried on a car which runs under the furnace hearth at right angles to the furnace length. Slag is transported to a cinder dump where it is crushed, loaded into dump cars, and taken either to the blast furnace or to the slag dump.

Open hearth facilities are housed essentially in six parallel building bays as set forth in Table II. The stripper building and skullcracker are conveniently located nearby the open hearth proper. Open hearth buildings are of flat roof, high-and-low bay design in 25-ft bays, one low bay alternating with three high bays.

A leanto is used principally for storage of alloys and miscellaneous materials. A part of the stockyard is roofed so that most materials except scrap are under cover. Elevated tracks in the stockyard permit the loading of scrap, limestone, feed ore, etc., directly into the charging boxes of a drag of buggies, which then may be shifted over crossovers into the charging bay.

The masonry department is staffed to take care of open hearth rebuilds, mill heating furnace repairs, and all normal steel plant masonry maintenance.

BLOOMING MILL

Heating facilities for the blooming mill consist of 24 soaking pits, fired by coke oven gas or fuel oil through a single burner in the center of the bottom. They are 13 ft 6 in. wide, 14 ft 3 in. and 20 ft long, and 7 ft 3 in. to 9 ft 6 in. in depth. Combustion air is preheated in refractory tile recuperators. Automatic controls are provided for temperature, fuel-air ratio and furnace pressure. There are also six preheating pits, each of the same holding capacity as one soaking pit and capable of heating ingots up to 1800 F.

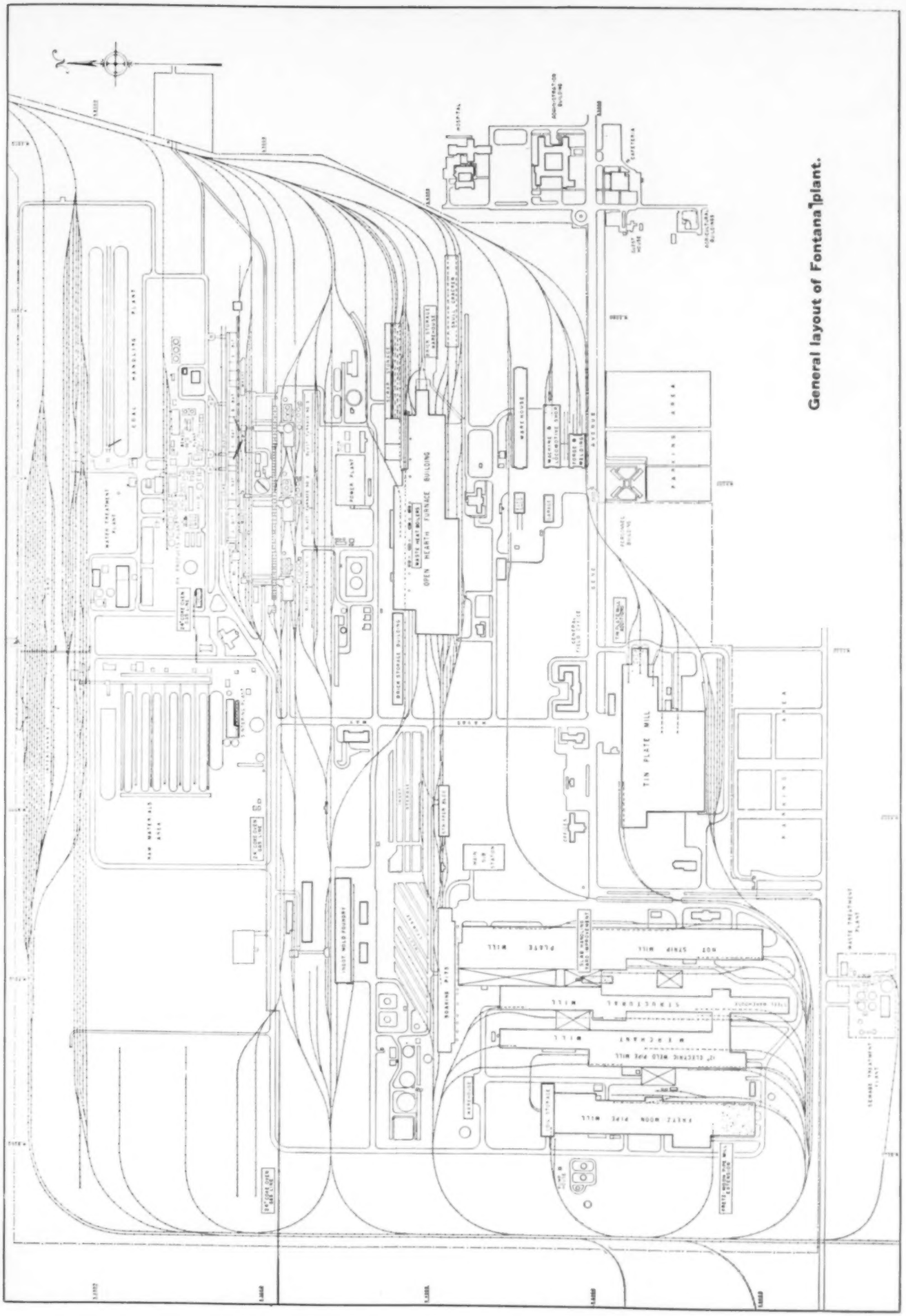
Normally, ingots charged into the soaking pits have temperatures averaging about 1800 F. Fuel consumption runs approximately 500,000 Btu per net ton of ingots.

The pit furnaces are arranged in a double row at right angles to the mill building. As ingots are drawn from the pits, they are placed in a pot car running along the row of pits and carried to a laydown table, from which they are transferred to another ingot buggy which runs

TABLE II

Open Hearth Buildings

	Length, ft-in.	Width, ft-in.	Cranes		
			No.	Capacity, tons	Span, ft-in.
Stockyard No. 1	750-0	85-0	2	20	80-0
Stockyard No. 2	825-0	100-0	3	10	100-0
Leanto	1300-0	45-0	....	....	....
Charging bay	1475-0	72-6	3	125/30	65-0
			2	10	Floor chargers
Pouring bay	1325-0	74-0	3	250/50/15	67-0
Ingot run	800-0	33-0	....	....	....
Mold preparation	700-0	80-0	2	15	75-0
Stripper building	300-0	65-0	2	[200]	61-0
Skull cracker and cinder yard	574-6	80-0	1	60/25	75-0
			1	40/15	75-0
			1	15	75-0



General layout of Fontana plant.

Twenty-four soaking pits, arranged in a double row, are fired by coke oven gas or fuel oil through a single burner in the center of the pit bottom.

at right angles to the first car and in line with the blooming mill table, which is some 340 ft from the soaking pit. This space was left for the future installation of a large blooming mill, in which case the present blooming mill would act as a secondary breakdown unit. At present, however, the mill must serve in both capacities.

The existing mill is a modification of the original installation, the changes including new housings, increased roll lift and faster reversal. As now constituted, the mill is a 36-in. two-high reversing unit, driven by a 5000-hp, 700-volt, 50-120-rpm, single armature motor. This motor, which can develop a maximum torque of 1,500,000 lb-ft, receives power from a motor-generator set consisting of two 2500-kw, 700-volt, d-c generators, a 14-ft diameter 77,000-lb flywheel, and a 4500-hp, 6600-volt, 490-rpm, wound-rotor induction motor. The field frames of these generators have been changed to laminated construction, and the original magnetic field control equipment was replaced by rotating regulator control equipment to help the mill meet the heavy duty imposed upon it.

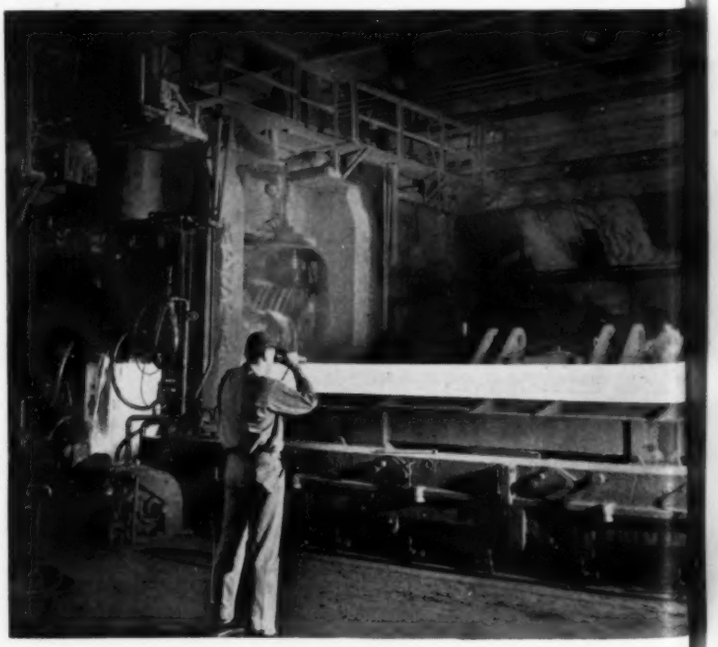
The cast steel housings of the mill are of closed top design, with posts 26 in. x 24 in. Rolls are 32 in. minimum and 36 in. maximum in diameter, with a body length of 82 in., and operate in composition bearings. The top roll is mechanically balanced by a counterweight.

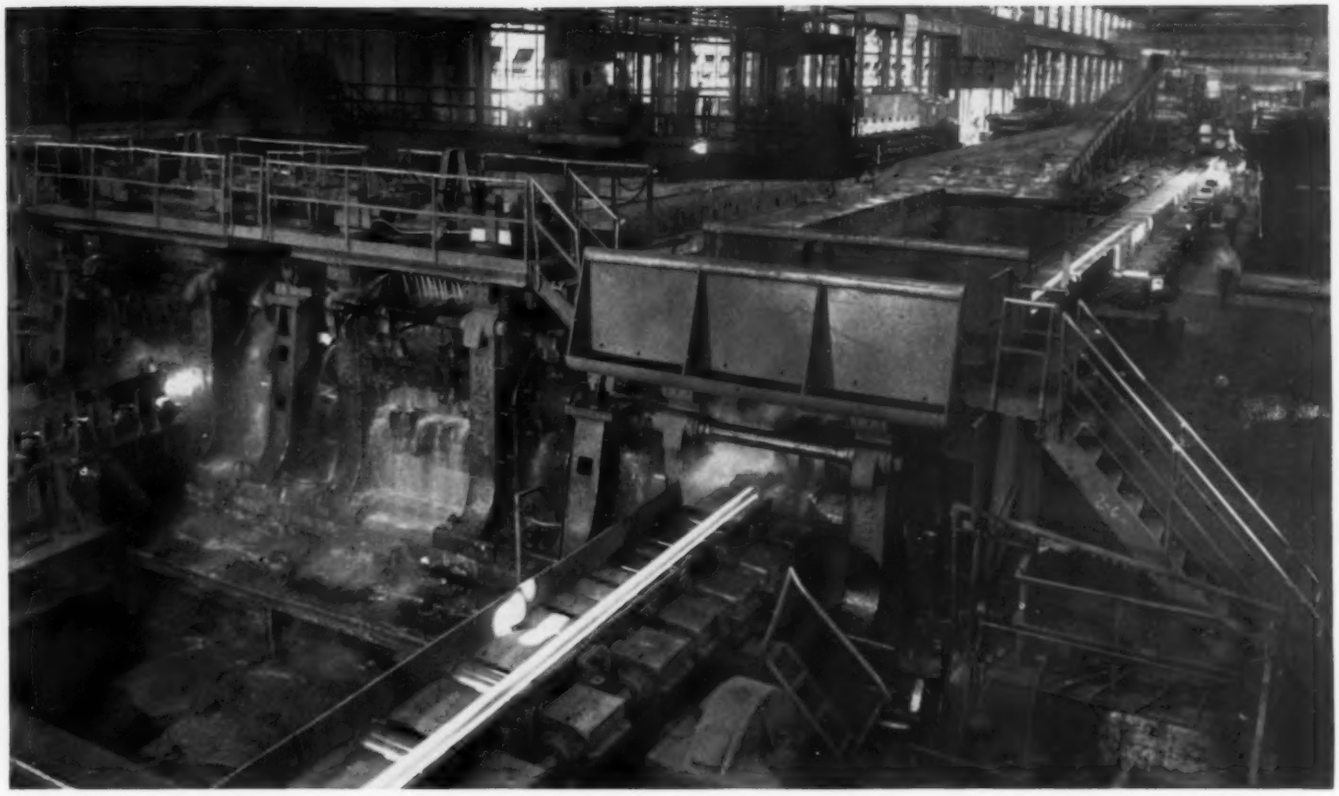
The mill housings permit a 38½ in. lift of the top roll, which, with changes in liners beneath the bottom bearings in accordance with the roll diameter, gives an opening of 40 in. between the rolls. Mill screws, of 12-in. diameter and 2-in. pitch, are driven by a 150-hp mill type motor under adjustable voltage control to give a maximum lifting speed of 4.5 in. per second.

Side guards and manipulators on each side of the mill are driven by two 100-hp motors, also under adjustable voltage control, as are the 49 ft 10 in. front and back mill tables.

The forged steel mill pinions are of 23 degree double helical design, 36-in. pitch diameter and 54-in. face.

The 36-in. blooming mill carries a very heavy rolling schedule of slabs and blooms. It has produced 119,000 tons in one month.





The 29-in. structural mill rolls angles, channels, I-beams, H-beams, slabs and billets at an average rate of 80 tons per hour.

They are connected to the rolls by 16-in. universal mill spindles with motor-operated spindle shifters.

Mill scale is flushed into a scale pit from which it is removed by grab bucket.

Approximately 138 ft beyond the mill is a hydraulically operated upcut bloom shear, capable of cutting sections up to 500 sq in. Crops are transferred by chain conveyor to crop boxes in a pit provided.

Immediately following the bloom shear is a 20-ft hot bed transfer to the left of the mill line, over which slabs and blooms are moved to pilers, and to the right is a 30-ft transfer leading to the west billet yard pilers.

The blooming mill produces blooms ranging from 8½ in. x 5 in. to 17 in. x 8 in., and slabs 4 in.-12 in. thick, and 22-36 in. wide, using 15-23 passes. Approximately 60 per cent of the mill's tonnage is slabs and 40 per cent blooms. Two ingots are often rolled in tandem where the length of the final sections permit the side guards to manipulate two lengths, thus increasing production materially. The mill rolls 155-195 tons per hr, and has rolled 119,000 tons in a month.

STRUCTURAL MILL

The blooming mill runout table proceeds on beyond the shear and transfers to a 29-in. structural mill, composed of a roughing stand, an intermediate stand and a finishing stand located side by side, all driven by a single 5000-hp, 800-volt, 70-150-rpm, d-c motor. This motor receives power from a motor-generator set consisting of two 2000-kw, 800-volt, d-c generators driven at 600-rpm by a 5600-hp, 6600-volt synchronous motor. The first two mill stands are three-high, and the finisher is two-high. Traveling tilting tables 50 ft long with 60-ft trailer tables on each side of the mill handle the steel into and out of the mill stands. Chutes on both sides of the mill catch lengths that might overtravel the trailer tables.

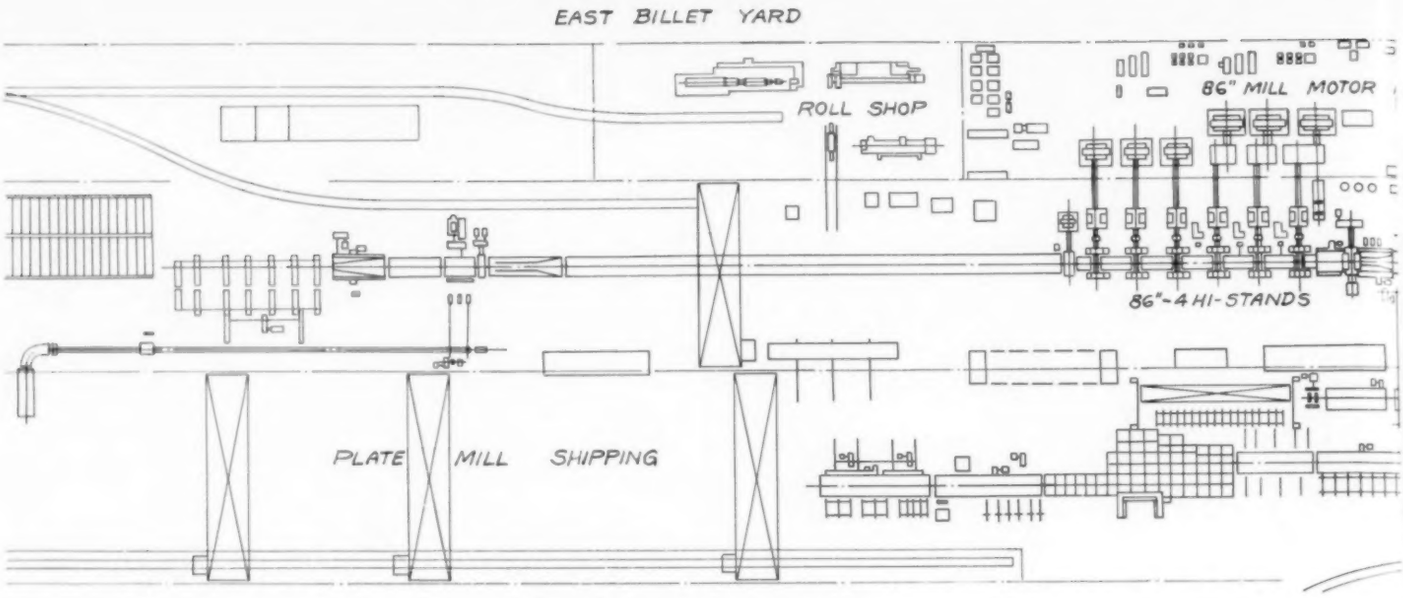
The mill housings are of cast steel, open top design. The top and bottom rolls of the three-high stands, and the top roll of the two-high stand are adjustable through manually operated screws. Rolls, with bodies 30¼ in. in diameter and 68 in. long, operate in water lubricated composition bearings.

Heating for the structural mill is accomplished in a 23 ft x 79 ft 6 in. triple-zone continuous furnace, fired with coke oven gas or fuel oil. Automatic controls are provided for temperature, fuel-air ratio and furnace pressure. Combustion air is preheated in a tubular silicon carbide recuperator. This furnace is so located that its charging end is in the east billet yard.

From the finishing stand, the runout table leads to a 60-in. sliding frame hot saw and saw gage, and onto cooling beds to the left or a billet transfer to the right. The cooling beds connect with a parallel table line leading to a roller straightener, an inspection bed, a cold shear and a piler bed. The billet transfer on the other side of the mill discharges into the west billet yard.

Steel comes to the structural mill in widths of 5½-16 in., thicknesses of 4-10 in., lengths of 14-21 ft, and weights of 1580-9565 lb. The mill produces 3½-8 in. angles, 5-18 in. channels, 4-20 in. I-beams, and 4-8 in. H-beams, as well as slabs, billets and some narrow universal mill plate. It rolls at an average rate of about 80 tons per hr.

The structural mill is one of the few units in the Fon-



Layout of plate and hot strip mill.

tana plant that is today virtually unchanged since its completion in 1944.

PLATE AND STRIP MILL

The Fontana plant started the production of wide strip in 1951 through the addition of an 86-in. continuous finishing train to an existing plate mill.

Heating facilities for this mill consist of two continuous recuperative furnaces, fired by coke oven gas or fuel oil in the conventional triple zone arrangement. One furnace has hearth dimensions of 23 ft x 79 ft 6½ in., the other, 20 ft x 79 ft 6½ in. Both furnaces are well insulated and metal encased, and have suspended arch roofs. Silicon carbide recuperators preheat combustion air to 600-700 F. Each firing zone is provided with automatic controls for fuel input and fuel-air ratio. Furnace pressure is also controlled automatically.

Slabs are brought by crane from the storage yard to a magazine elevator feeder, from where they are moved to a charging table 78 ft long running across the back ends of the furnaces. Two rack type pushers on each furnace move the slabs from the charging table and on through the furnaces.

Through the action of the furnace pushers, heated slabs are expelled from the furnace onto the mill approach table.

Slabs first pass through a reversing vertical edging stand, the rolls of which are adjustable up to a maximum opening of 110 in. through the action of two 50-hp mill type motors. The rolls operate in roller bearings.

Details of the drive, speed, etc., of this stand, as well as of the other stands in this mill, are given in Table III.

The second unit of the mill is a two-high reversing rougher, with a maximum roll lift of 31 in. through the action of 16-in. mill screws of 1½-in. pitch, driven by two 100-hp motors. The top roll is balanced by hydraulic pressure of 500 psi. Roll necks run in oil-film bearings. This stand is driven by a twin motor drive, with one motor directly connected to each roll. Power for these motors and for the edger drive comes from a flywheel motor-generator set composed of two 3000-kw and one 1250-kw generators, all 750-volt d-c, driven at 355 rpm by a 6000-hp, 6600-volt, wound-rotor induction motor.

Mill tables on each side of the mill are 13 ft 4 in. long, and are driven by mill type motors under adjustable voltage control. The entry table is equipped with tapered rolls for slab turning so that broadside rolling may be done to increase slab width.

The third mill stand is a three-high unit. The work rolls operate in roller bearings while the top and bottom rolls in this stand run in composition roll neck bearings, and their maximum opening is 14 in. The screwdown mechanism is similar to that on the two-high stand except that it operates under adjustable voltage control. The roll balance is operated by a 500-psi, oil-hydraulic system, and oil-hydraulic power at 1400 psi shifts the middle roll up and down.

The variable speed drive of this stand receives power from a motor-generator set consisting of two 3000-kw, 750-volt, d-c generators driven by a 6000-hp, 6600-volt wound rotor induction motor.

A tilting table 32 ft 5 in. long is installed on each side of the three-high stand. These tables are driven at speeds up to 500 fpm by two 100-hp motors under adjustable voltage control. The tables carry motor-operated sideguards and are tilted through articulated levers actuated by two 150-hp motors.

The foregoing stands comprise the plate mill, which normally reduces slabs 4-12 in. thick, 22-36 in. wide and 65-216 in. long down to plate 3/16-4 in. thick and 36-96 in. wide. The capacity is approximately 840,000 tons of plate in a year.

When rolling plate, the product leaves the three-high stand and proceeds over the table containing a light leveler to a chain-and-dog type transfer, leading to a parallel table line in the adjoining building bay. This

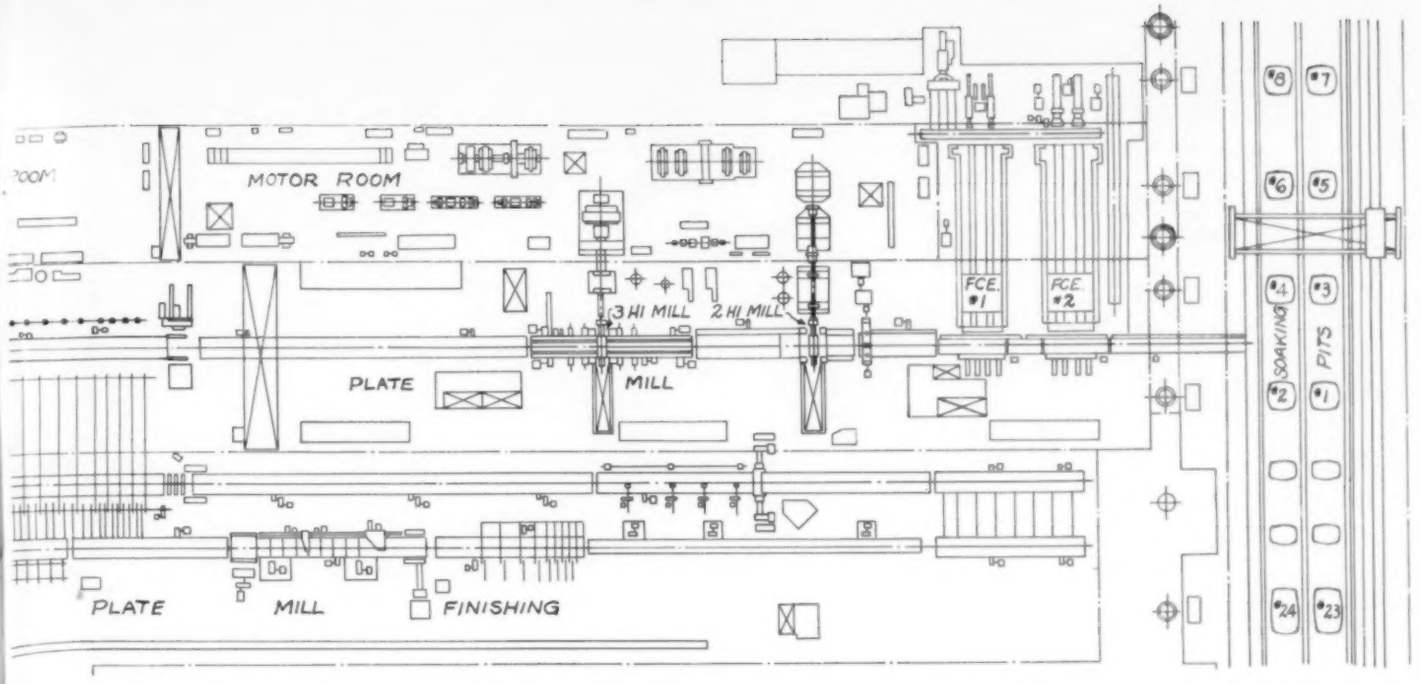


table contains a ⅜-in. leveler on one end, leading to a piler. In the other direction, the table contains an end shear and a rotary side trimmer, and leads to a second transfer which connects with another table line. This line contains an inspection table, an end shear, a heavy leveler, scale table, caster bed and side shear.

When the mill is rolling strip, the breakdown from the three-high stand proceeds over the table, through a crop shear, and through the new six-stand 86-in. continuous finishing train 333 ft distant. Some details of the drives of the finishing stands are given in Table III.

Power for the six d-c drive motors of the finishing stands is furnished by three 5000-kw rectifiers.

This three-high mill, with a preceding vertical edger and a reversing two-high stand, serves as plate mill and hot strip rougher.

The screwdown of each finishing stand is driven by two 75-hp mill type motors, with a magnetic clutch connecting the two drives to allow operation of the screws separately or in unison.

Roller bearings are used on the work roll necks, with oil-film bearings on back-up roll necks.

Loopers, to take up any slack in the strip as it passes through the train, are located between all stands. They are actuated by torque type d-c motors controlled from a special motor generator set.

Good surface on the finished product of this mill is insured by hydraulic descaling sprays, top and bottom, at the entry of the two-high and three-high stands, at the delivery side of the three-high stand, and at the entry to the finishing train. Water is supplied to the sprays at 1200-1300 psi pressure by three 600-gpm pumps.

As the steel progresses through the mill, its temperature may be checked by four radiation pyrometers, one between the two-high and three-high stands, one just ahead of the finishing train, one between No. 5 and No. 6 finishing mills, and one just ahead of the coilers.

At the delivery end of the finishing train is a hot flying shear designed to cut lengths between 20 and 62 ft. It is driven by two 150-hp, 187-550-volt, 376-1100-rpm, d-c motors under adjustable voltage control.

Sheared material is conveyed through the pinch rolls into a piler, from where it is transferred to a storage area.

Approximately 290 ft beyond the finishing train are two down-coilers with 30-in. collapsible mandrel driven by 300-hp motors and surrounded by four sets of driven wrapper rolls. Pinch rolls deflect the strip into the coilers, coils are stripped from the mandrels, and transferred to a conveyor which carries them into a storage area.

All main drive motors, gear sets, motor-generator sets, control equipment and switch gear for the mills

TABLE III

Strip Mill Data

Stand	2-high or 4-high	Length of roll body, in.	Roll diameter, in.		Distance from preceding stand, ft-in.	Drive motor			Gear ratio	Roll rpm	Strip speed, fpm
			Work	Backup		Hp	Voltage	Rpm			
Hot strip mill											
Edger	Vertical	30	44			1500	750	80/240	1.57	34/77	391/875
Reversing rougher	2	110	45		27-5½	②3500	750	30/75	Direct	30/75	353/883
Rougher	3	110	26½	41½	100-0	7000	750	50/120	1.50	33.3/80	362/870
No. 1 Finisher	4	86	27	53	333-0	5000	600	125/250	4.06	31/62	219/438
No. 2 Finisher	4	86	27	53	19-0	5000	600	125/250	2.2	57/114	402/804
No. 3 Finisher	4	86	27	53	19-0	5000	600	125/250	1.47	85/170	600/1200
No. 4 Finisher	4	86	27	53	19-0	5000	600	110/220	Direct	110/220	778/1556
No. 5 Finisher	4	86	27	53	19-0	5000	600	125/250	Direct	125/250	885/1770
No. 6 Finisher	4	86	27	53	19-0	3500	600	110/290	Direct	110/290	778/2050
Skin pass mill	2	86	32			500	2300	514	10.65	48	402
Tinplate department											
Cold reduction mill											
No. 1 Stand	4	44	21	53		1500	600	70/210	Direct	70/210	385/1155
No. 2 Stand	4	44	21	53	13-0	2500	600	110/275	Direct	110/275	605/1513
No. 3 Stand	4	44	21	53	13-0	②1500	600	175/425	Direct	175/425	962/2338
No. 4 Stand	4	44	21	53	13-0	②1500	600	250/600	Direct	250/600	1375/3300
No. 5 Stand	4	44	21	53	13-0	②1750	600	400/745	Direct	400/745	2200/4097
Tinplate temper mill											
No. 1 Stand	4	44	9	44		600	600	225/350	Direct	225/350	2590/4030
No. 2 Stand	2	44	28		13-0	600	600	400/550	Direct	400/550	2930/4030

are located in a motor room 650 ft long x 65 ft wide adjacent to the mill building.

This room is ventilated by a recirculating system, with air being drawn down through the rotating machinery, passing on through air coolers, and back into the motor room. Two air filters clean make-up air before it is introduced into the system.

At one end of the motor room is a roll shop serving the strip and plate mill. It contains two 60-in. roll grinders, one 60-in. roll lathe, and degreasing equipment for bearing maintenance.

The hot strip mill uses slabs 4-5½ in. thick, 22-36 in. wide and 65-216 in. long. It produces No. 18 gage in widths up to 45 in., No. 16 gage up to 50 in wide, No. 14 gage up to 60 in. wide, and No. 12 gage and heavier up to 72 in. wide. Product averages about 0.120 in. in

This 86-in. hot strip finishing train, installed in 1951, rolls breakdowns from the plate mill into strip at an average rate of about 145 tons per hour.

Hot rolled strip is put through a 50-in. continuous pickling line prior to cold rolling and finishing.

thickness, with an average rate of about 145 tons per hr. About 38 per cent of the product is shipped in flat form and 62 per cent in coils.

Hot rolled finishing equipment includes a 32 x 86-in. skin pass mill and a $^{3}/_{16}$-in. shearing line. New 54-in. shearing line and 54-in. slitting line are being installed.

TINPLATE MILL

A recent addition which has contributed to the diversification of products of the Fontana plant is a complete tin plate mill with an annual capacity of 200,000 tons. This division includes a 50-in. continuous pickling line, a five-stand 44-in. cold reduction mill, a 38-in. electrolytic cleaning line, five portable annealing covers, a two-stand, 44-in. temper mill, a coil preparation line, a 38-in. electrolytic tinning line, seven hot dip tinning machines, and a shearing and classifying line.

Hot rolled coils are carried to the entry end of the pickling line by overhead crane and, by conveyor, down-ender and tilter, brought to the coil box. The steel then passes through a processing unit, an up-cut shear, a flash welder and trimmer, a mechanical stitcher and a looping pit.

Three 80-ft tanks, constructed of steel plate lined with rubber and with acid-resistant brick, hold the pickling solution. Immersion of the strip in the baths of each tank is controlled by magnetic loop controls. Tank covers are of rubber-lined steel, and are vented through a scrubber and out through a 60-ft stack.

The strip then passes through a cold water spray, a 25-ft hot water tank and a hot air dryer, then through another looping pit, a 60-in. up-cut shear, side trimmer and up-coiler.

The new cold reduction mill (Table III) is a five-stand unit designed to reduce coils averaging about 0.080 in. in thickness down to a minimum of 0.007 in. Coils are brought to the mill entry ramp by a 30,000-lb lift truck. A coil rotating rig, coil box, guides and a pair of pinch rolls handle the steel as it enters the mill.

Work rolls of forged steel, are 21 in. x 44 in., and operate in roller bearings. Backup rolls are of cast steel, 53 in. x 44 in., and run in oil-film bearings.

Mill screws are of forged steel, 18 in. in diameter and of 0.4 in. pitch. On each stand, the screwdowns are driven by two 50-hp, d-c, mill motors, connected by a magnetic clutch.

On leaving the last stand, strip is coiled on a 16½-in. diameter x 48-in. long overhung mandrel tension reel with wedge type expanding and collapsing drum, driven by two 400-hp, 225/1000-rpm, 300-volt motors in series. The strip is guided around the mandrel by a hydraulically operated belt wrapper. When the coil is through the mill, the mandrel is collapsed and a carriage lifts up under the coil and moves it at right angles to the mill line to a delivery ramp.

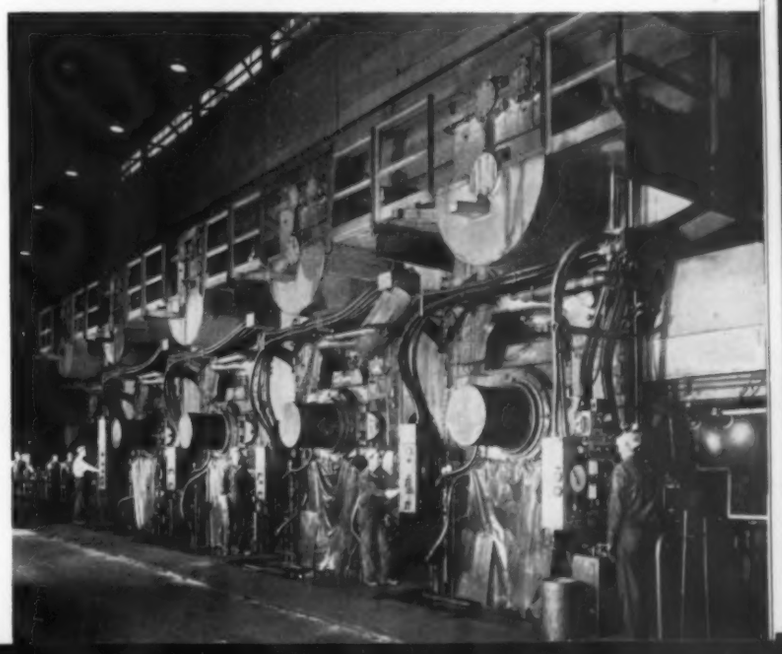
An X-ray gage is located at the delivery side of No. 5 stand to measure strip thickness.

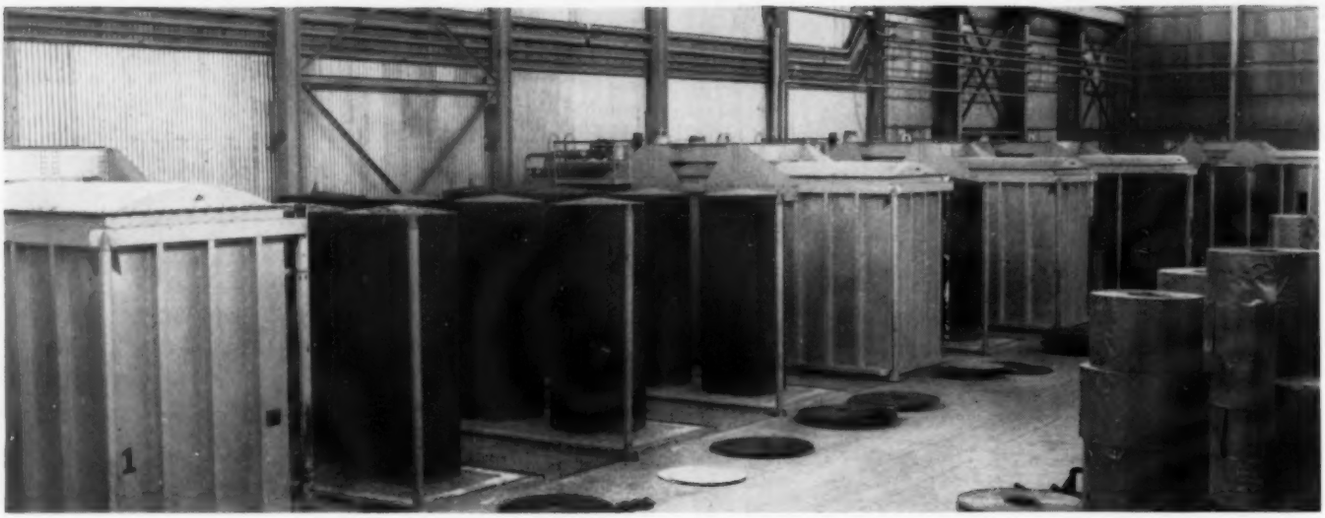
The drives of the cold reduction mill receive power from two motor-generator sets, one having a 1200-kw generator for No. 1 stand, a 2000-kw generator for No. 2 stand and a 2400-kw unit for No. 3 stand. The second set contains a 2400-kw generator for No. 4 stand, two 1400-kw units for No. 5 stand and a 640-kw unit for the tension steel. All of these generators are 600 volts, d-c, and each set is driven by an 8200-hp, 6900-volt, 514-rpm motor.

The main drive motors, motor-generator sets, exciter sets and switch gear are located in a motor room provided with a down-draft closed ventilating system. Dry fiber-glass filters remove commutator dust between the rotating machines and the air coolers.

In the basement of the cold reduction mill are hydraulic systems for the roll balance, and the coil han-

This five-stand 21-in. and 53-in. x 44-in. cold mill reduces hot rolled pickled strip to tinplate gages.





Portable cover-type furnaces are used to anneal cold rolled material. Each furnace will accommodate four stacks of five coils each, totaling about 460,000 lb.

dling devices, lubrication systems for the mill units, and the roll coolant system.

One 38-in. electrolytic cleaning line has been provided for removing the oily residue from the cold rolling operation prior to annealing. This line operates at speeds up to 2000 fpm. Current is supplied to the electrolytic equipment by two 75-kw, 12/30 volt, d-c generators.

Annealing facilities at present consist of five portable cover furnaces, with 15 bases. The covers are 7 ft 6 in. wide x 31 ft 8 in. long x 14 ft high, and will take four stacks of five coils, for a total charge of about 460,000 lb. An inner cover protects each individual stack. Each furnace has an estimated capacity of 44,000 tons per year. The furnaces are indirect-fired by high pressure gas burners, with the gas and air proportioned and mixed by a carburetor on each furnace. Automatic temperature control regulates the gas input to the furnace, and when any one of the individual stacks reaches a given temperature, the control becomes individual for each stack.

Each of the 15 bases has four coil supporting plates designed for the circulation of controlled atmosphere gas within the inner covers under the action of a fan under each plate. The protective atmosphere is generated in a unit capable of producing 8500 cfm of gas containing 0.5-0.6 per cent CO, not more than 0.2 per cent CO_2 and not more than 7 per cent H_2, with the remainder N_2. This gas is dehumidified to a dew point of –40 F and discharged at 12-in. water column pressure.

Two more annealing furnaces and six bases are being installed.

After annealing, the coils are put through a two-stand temper mill (Table III) to obtain the flatness, hardness and finish desired in the tinplate. This unit consists of a 9 in. and 44 in. x 44 in. four-high stand and a 28 in. x 44 in. two-high stand. The four-high stand is driven through its back-up rolls rather than through the work rolls, as is more conventional. The drives on this mill draw power from a motor generator set, composed of two 1000-kw, 700-volt, d-c generators driven by a 2800-hp, 6600-volt, 720-rpm motor.

Coils are brought to the temper mill by overhead crane, and a conveyor, downender and coil car combine to place them on the payoff reel. The drum of this reel has a 14½-in. diameter when collapsed and 17½ in. when expanded, and the entire reel may be moved 6 in. in either direction from the centerline by a hydraulic cylinder. The strip then passes through an entry tension unit with 20-in. tension rolls and 8-in. holddown rollers.

At the delivery end of the mill is a duplicate tension device, but of opposite hand, a reel with belt wrapper, a stripper mechanism and coil car, and a delivery conveyor.

From the temper mill, coils may go to a side trimming unit if electrolytic tinning is intended, or to a shearing line if the product is to be hot dipped.

A 38-in. electrolytic tinning line, designed for a maximum speed of 1200 fpm, is capable of handling coils up to 66 in. outside diameter, 38 in. width and 30,000 lb weight. Coils are brought by overhead crane and placed on either of two coil cars, which center the coils on the mill line. The strip first passes through a shear, a flash welder, a looping pit and an entry tension bridle, before entering the cleaning and pickling section of the line. This section consists of six vertical tanks containing successively alkaline cleaning solution, water rinse, pickling solution and water rinse, followed by a final spray rinse.

The plating section contains six vertical rubber-lined tanks 10 ft deep, followed by another tank which collects the solution carried over by the strip. Pure tin anodes are used in the acid-type solution, with the strip acting as the cathode.

The strip then passes through an electric induction type reflow unit, a water quench tank, chemical dip tanks, a scrubbing unit and a dryer.

An electrostatic oil next applies vaporized oil from an ionizing chamber to the strip.

The strip is pulled through the line by a drive bridle, and passes on through a looping pit, a roller leveler, and a flying shear, which can cut lengths of 18-43 in. The cut lengths then pass on through a classifier which sorts

them into primes, seconds and rejects, through the automatic actions of a thickness gage and two pinhole detectors located just after the oiling unit, or through manual push buttons operated by inspectors just after the flying shear.

Major electrical equipment for the line, including motor-generator sets, boosters, transformers, control panels, etc., are located in a basement area, as are electrolyte storage tanks.

A project is under way to add four more plating tanks in this line and put the final cut-up shear and classifier into a separate line, so that the line can be operated at higher speeds, with resultant greater production.

Coils intended for hot dip tinning first pass through a shearing and classifying line, where they are side trimmed, cut to lengths of 18-43 in. and automatically separated by a pinhole detector and flying micrometer into primes and rejects. Seven 75-in. hot dip tinning lines are provided, designed to handle sheets 0.006-0.033 in. thick, 16½-36 in. wide, and 18-37½ in. long with automatic feed, or 37½-43 in. long with manual feed. These units employ vacuum cup type mechanical feeders and include an electrolytic pickling unit, tinning machine and pot, wet washer, branner, and an inspection, assorting and piling unit.

Miscellaneous equipment in the tin plate mill includes machines for salvaging black plate, three roll grinders (53 in. x 168 in., 36 in. x 144 in., 24 in. x 120 in.), a roll blasting machine, facilities for the repair of tinning machines and battery charging, and a box shop.

To handle spent acid from the pickling units, a complete waste disposal unit was installed. The waste solutions are accumulated in two 25,000-gal rubber-lined steel tanks, and as desired, fed into two 7-ft diameter neutralizer tanks, 14 ft high, arranged in series so that the outflow from the first tank moves by gravity into the second tank. The outflow from the second tank is discharged to a 75-ft diameter reactor clarifier unit. Pebble quick lime is slaked and the solution fed with automatic proportioning into the neutralizer tanks. Water leaving the clarifier is put through four sand-bed pressure type filters.

SKELP AND MERCHANT MILL

The merchant mill was originally installed in 1945 as a 21-18-14-10-in. mill consisting of 16 stands and 2 vertical edgers in a cross-country layout with continuous roughing. Subsequent installation of pipe mills at Fontana required a supply of skelp, and the merchant mill was changed somewhat to furnish this.

Heating facilities for this mill consist of one side-charge, side-discharge continuous heating furnace 33 ft x 50 ft, fired with coke oven gas or fuel oil. It is equipped with a tile recuperator, and with automatic temperature, fuel-air ratio and furnace pressure controls. The furnace pusher moves the billets down over the sloping hearth, and an ejector pusher moves the front billet out through the side of the furnace onto the mill approach table, where it may be cropped or divided in a hot billet shear.

The mill now consists of four 21-in. stands, eight 18-in. stands, two 14-in. stands and three vertical edgers. Details of these stands are given in Table IV. When rolling skelp, only the first ten stands are used, in a straight continuous layout, with the material delivered from stand No. 8-B. The material may be cut to length by a flying shear located just after this stand, or it may proceed to two upcoilers if continuous lengths are desired.

To insure good product surface, water sprays at 1500 psi pressure are provided at the entry sides of No. 1, 3 and 5 stands, top and bottom.

When rolling merchant mill products, the steel is taken from stand No. 8 to No. 11, and finished either out of No. 12 or No. 14, depending on the reduction re-

After annealing, the cold rolled material is put through a two-stand temper mill to obtain the desired flatness, hardness and finish.

This 38-in. electrolytic tinning line can handle coils up to 66 in. outside diameter, 38 in. in width and 30,000 lb in weight.

TABLE IV

Skelp and Merchant Mill Data

Stand	Nominal size, in.	Distance from preceding stand, ft-in.	Motor hp	Motor rpm	Gear ratio	Roll rpm	Roll face speed, fpm
No. 1 Edger	....	....	100	300/900	41.89	7.16/21.48	.....
No. 1 Stand	21	10-0	300	112.5/300	12.6	8.93/23.8	49.2/130.8
No. 2 Stand	21	28-0	400	200/400	12.6	15.9/31.8	87.5/175.
No. 3 Stand	21	38-0	500	150/400	10.5	14.3/38.1	78.8/210.
No. 4 Stand	21	14-0	500	150/400	7.59	19.8/52.8	109/290
No. 2 Edger	..	10-0	100	500/1250	19.29	26.2/64.8	.....
No. 5 Stand	18	8-0	600	300/680	7.59	39.6/89.8	186/422
No. 6 Stand	18	14-0	600	300/680	5.54	54.1/122.8	255/578
No. 7 Stand	18	10-0	700	300/850	5.54	54.1/153.3	255/720
No. 8 Stand	18	10-0	700	300/850	4.38	68.6/194.2	323/913
No. 3 Edger	12	5-0	20	320/960	2.66	120.3/360.9	362/1086
No. 8-A Stand	18	16-0	1000	200/600	1.98	98/295	462.5/1392.4
No. 8-B Stand	18	16-0	1000	200/600	1.98	98/295	
No. 11 Stand	18	*	1500	235/660	3.54	66.4/186.5	313/880
No. 12 Stand	18	*					
No. 13 Stand	14	*			2.33	101/283	370/1037
No. 14 Stand	14	*	500	125/500	Direct	125/500	458/1830

*This stand not in tandem line with preceding stand.

quired. Stands No. 11, 12, 13 and 14 are in cross-country layout, with transfers connecting the four table lines. Small rounds may be looped from No. 8 to No. 11 stand and from No. 12 to No. 13 stand by repeaters.

Steel finished out of No. 12 stand proceeds over the runout table and across a 125-ft cooling bed. Steel finished out of No. 14 stand may be diverted to either of two pouring reels, or it may pass through a rotary bar shear and over the runout table to a 250-ft cooling bed. The two cooling beds connect onto a common table line which contains a cold bar shear.

All of the housings of this mill are of open top design. Roller bearings are applied to the roll necks of the vertical edgers, and the first 10-mill stands. Composition bearings are used in the last four stands.

All of the mill drive motors draw d-c power from a 2500-kw, 6-phase, 600-volt rectifier, the first installation of this type in the United States.

COLD REDUCTION DEPARTMENT

In 1947 a cold reduction mill was installed to finish flat material that had been hot rolled on the merchant-skelp mill. The hot rolled material is put through a semi-continuous pickler consisting of a ¼ x 28-in. down-cut shear, coil box, roller leveler and scale cracker, welder, a 30-ft hot water preheat tank, two 50-ft acid tanks, cold water spray tank, hot water rinse tank, dryer, shear and up-coiler.

Cold reduction is performed on a four-high 12-in. and 26-in. x 24-in. reversing mill driven by a 1000-hp, 600-volt, 400-960-rpm, d-c motor. Each reel is driven by a 300-hp, 250-volt, 500-1450-rpm, d-c motor. In line with the mill is a coil box with cover, and a pinch roll and leveler unit. The coils are originally fed into the mill through these units, and the reels handle them in subsequent passes. The drives of this mill receive power from a motor-generator set consisting of one 1000-kw, 600-volt generator, one 1000-kw, 250-volt generator and two 300-kw, 250-volt generators, all driven at 720 rpm by a 3500-hp, 6900-volt synchronous motor. A maximum rolling speed of 1250 fpm may be attained.

The mill capacity is approximately 5500 tons per month of strip 10⅜-16⅜ in. wide and 0.020-0.0747 in. thick. Coils range 26-38 in. outside diameter, and may have a maximum weight of 4200 lb.

This department also contains nine gas-fired cylindrical bell type annealing furnaces with 18 bases, a skin pass mill, a shearing line, a slitting line and an oiling machine.

PIPE MILLS

Fontana entered the pipe field in 1948 with the installation of a continuous butt weld pipe mill, and in 1950 added an electric weld pipe mill.

The continuous butt weld mill is designed to produce ½-4-in. pipe from skelp 4½-15¾ in. wide and 0.100-

Installed in 1947, this 24-in. reversing cold mill handles strip 10⅜-16⅜ in. wide.

0.290-in. thick. It is of conventional layout, with coil payoff, flash welder, pinch rolls and magnet roll units feeding the skelp into a continuous furnace. The furnace is 159 ft 8½ in. long x 2 ft 9-in. wide and is fired with coke oven gas. It is equipped with automatic controls for temperature, fuel-air ratio and furnace pressure, and with cast iron and alloy fin-tube recuperators.

As the heated skelp leaves the furnace at about 2450 F, nozzles at the delivery end of the furnace blow air at about 1.5-psi pressure on the skelp edges, increasing their temperature to fusion point.

The skelp then passes through the mill, which consists of a forming pass, a welding pass and eight reduction passes. These stands are alternately vertical and horizontal and each stand is driven by a 15-hp, 250-volt, d-c motor so as to give pipe speeds of approximately 128-520 fpm.

Located 14 ft after No. 10 stand is a flying hot saw, after which the lengths of pipe proceed over a 20 x 46-ft cooling bed and through three sizing and descaling stands, each driven by a 25-hp motor. After passing over two more cooling beds, the pipe may proceed through a straightener or over still another cooling bed to another straightener, depending on its size.

All drives on this mill draw power from two special motor generator sets.

Water sprays at 800-psi pressure are placed between stands No. 11 and 12, to assist in scale removal.

The electric weld pipe mill is designed to produce pipe 6⅝, 8⅝, 10¾, and 12¾ in. in diameter from skelp 21⅜-43¼ in. wide and 0.188-0.400 in. thick. Cut lengths 47-52 ft long are fed through a roller leveler, a shot blast unit to clean the edges of the skelp, an edge trimmer, and into the mill which consists of ten forming passes, a welding machine and five finishing stands. The skelp is progressively formed into cylindrical shape in the forming stands.

In the welding unit, two circular electrodes contact the edges of the skelp, introducing a heavy current coming from a special motor-generator set consisting of a 2000-kva, 480-volt, 60-cycle, single-phase generator driven at 900 rpm by a 2500-hp, 6600-volt motor. Thus, through the resistance set up by the seam where the two edges of the skelp meet, intense local heat is generated. At the same time, the pipe is kept under pressure by the electrodes on the top and welding rolls on the two sides and bottom. This combination of heat and pressure causes the two edges to be welded together.

The pipe then goes through five sizing passes, wherein it is brought down to the proper size and shape.

Except for three idler passes in the forming train, each stand is individually driven by a 20/25-hp, 230-volt, 300-1200-rpm, d-c motor, power coming to the drives from a 250-kw motor-generator set.

The finished pipe is then straightened, inspected, tested and prepared for shipment. The mill can produce about 20,000 tons of pipe per month.

Continuous butt weld pipe is produced in ½-4 in. diameters. The mill operates at pipe speeds of 128-520 fpm.

PLANT SERVICES

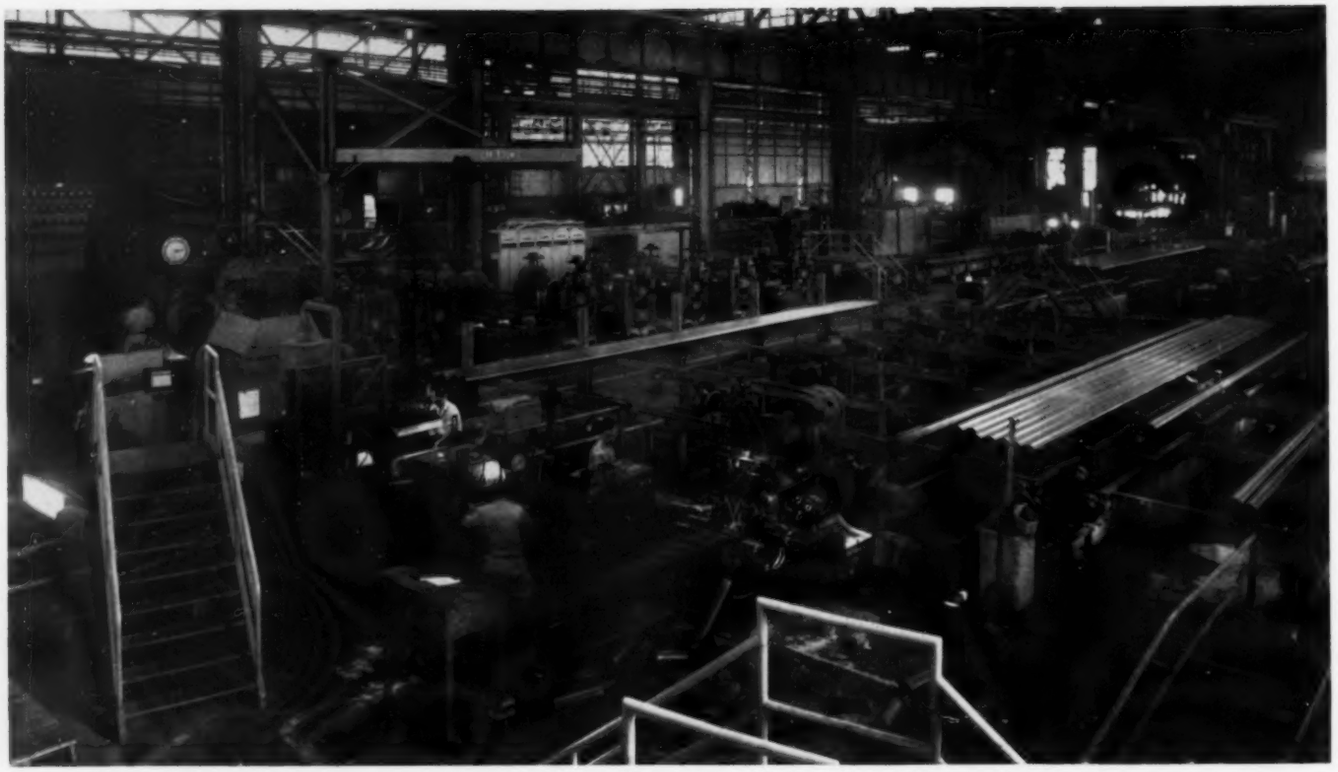
Electric power for the plant is purchased from the utility company serving the district. Two 69,000-volt, 60-cycle lines come into the main substation where transformers totaling 55,000-kva capacity reduce it to 6900 volts. At this voltage, power is distributed to substations at the plate mill and strip mill motor rooms, and at the power house, open hearth and tin plate mills. From the power house, 6900-volt power is distributed to substations at the coke plant, sintering plant, open hearth and machine shop area. The blooming mill, structural mill and merchant mill are served out of the plate mill substation.

Where required, power is reduced to 2300 volts and 480 volts. Auxiliary power is principally 440 volts. D-c power at 250 volts for auxiliaries is provided by two 1000-kw motor-generator sets at the plate mill, two more at the power house, two 1000-kw rectifiers at the open hearth, one 1000-kw rectifier at the strip mill, two 500-kw rectifiers at the tin mill, one 1500-kw rectifier in the 29-in. mill motor room, one 1000-kw rectifier at the lower end of the 29-in. mill, and one 1000-kw rectifier at the lower end of the 29-in. mill, and one 1000-kw rectifier at the merchant mill. Some small isolated motor-generator sets are also installed in several other areas requiring d-c power.

The plant sets up a 30-minute demand of about 52,000 kw and consumes approximately 25,000,000 kwhr per month.

Steam for the plant is provided from two producing centers. The power house contains four boilers which operate at 400-psi pressure, 700 F total temperature, one of 100,000-lb per hr capacity and three of 160,000 lb per hr. An additional 160,000 lb per hr is being installed. These ratings are based on coke oven gas or oil. They are fired primarily with blast furnace gas, with standby facilities for coke oven gas and fuel oil, and are equipped with full automatic control. In addition, there are seven waste heat boilers at the open hearth, two of 7800 sq ft and five of 13,000 sq ft heating surface.

Water for the Fontana plant comes from a company serving the area, and from two wells on the plant property. The raw water is treated with lime and sodium aluminate, recarbonized and filtered, and then flows into either a domestic reservoir or an industrial



The electric weld mill produces pipe 6⅝, 8⅝, 10¾ and 12¾ in. in diameter from 47-52 ft lengths of skelp.

reservoir. The former supplies water for fire protection, drinking and sanitary purposes. Waste water from the domestic system passes through a sewage treating plant, and the effluent flows into the industrial system.

Vertical and horizontal rolls form skelp lengths into cylindrical shapes which are then welded shut in a resistance welding machine.

The industrial reservoir supplies water to a number of individual water systems provided with cooling towers and recirculating pumps. Each of these systems operates on a certain type of service, such as cooling in motor rooms and reheating furnaces, cooling of mill bearings and rolls, cooling of open hearths, blast furnaces and coke plant equipment, and cleaning of blast furnace gas. Normally, all make-up water goes into the first system, serving the motor rooms and reheating furnaces. Make-up for each successive system listed comes from the system immediately preceding it.

Pumping requirements have been reduced materially by using water through several applications in series, instead of having separate leads to each point. This permits higher water velocities, which has reduced the build-up of solids while reducing water usage and improving the operation of the cooling towers.

Through use of the closed recirculating systems, and with the aid of a catch basin, make-up water to the entire water system amounts to only about 3 per cent of the 100,000-gpm average circulation.

As is evident from the foregoing, water conservation has been carried to a very high degree, which results in a minimum amount of waste to be disposed of.

Shop facilities include the usual machine, forge, welding, pipe, electric, boiler and locomotive shops, as well as a carpenter and pattern shop and a foundry equipped for pouring metal from the blast furnaces. The foundry shop produces ingot molds and other castings for outside sale as well as for plant use. Oxygen is piped around the plant from a central converter which is charged with liquid oxygen. All plant switching is done by diesel-electric locomotives.

86" flying shear cuts 1/16" to 1/2" sheets or plates at 1550 ft. per minute... *with help of TIMKEN® bearings*

THE 86" flying shear on this hot strip mill at the Kaiser Steel Corporation's Fontana Works accurately cuts 1/16" to 1/2" thick sheets or plates into 20 to 60 foot lengths. Although the strip is moving as fast as 1550 feet per minute, the shear holds consecutive sheets or plates to extremely close length limits. To insure this accuracy with minimum maintenance, United Engineering & Foundry Co. mounted the shear drum rolls and drive gears on Timken® tapered roller bearings.

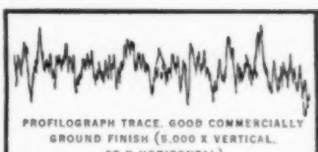
Timken bearings in the shear drum rolls take the terrific shock loads of the shearing operation. Their case-hardened rollers and races have tough, shock-resistant cores.

Specially designed gears regulate the length of cut in 1/4" steps. Timken bearings keep the gears in accurate and positive alignment. And Timken bearings' tapered construction lets them take any combination of radial and thrust loads. They take the heavy thrust of the helical gears with ease. They also locate all of the shafts in this intricate gear train.

Be sure to specify Timken bearings in the machines you build or buy. Look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

UNITED ENGINEERING & FOUNDRY CO. uses Timken tapered roller bearings on the shear drum to insure maximum precision with minimum maintenance.


PROFILOGRAPH TRACE, GOOD COMMERCIALLY GROUND FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
PROFILOGRAPH TRACE, TIMKEN BEARING FINISH (5,000 X VERTICAL, 30 X HORIZONTAL)
OPTICAL FLAT, PERFECT FINISH

SMOOTH TO MILLIONTHS OF AN INCH

Surface finish of high quality Timken bearing rollers and races is so smooth that it takes a profilograph to measure its smoothness. This instrument measures surface variations to a millionth of an inch, as shown at the left.

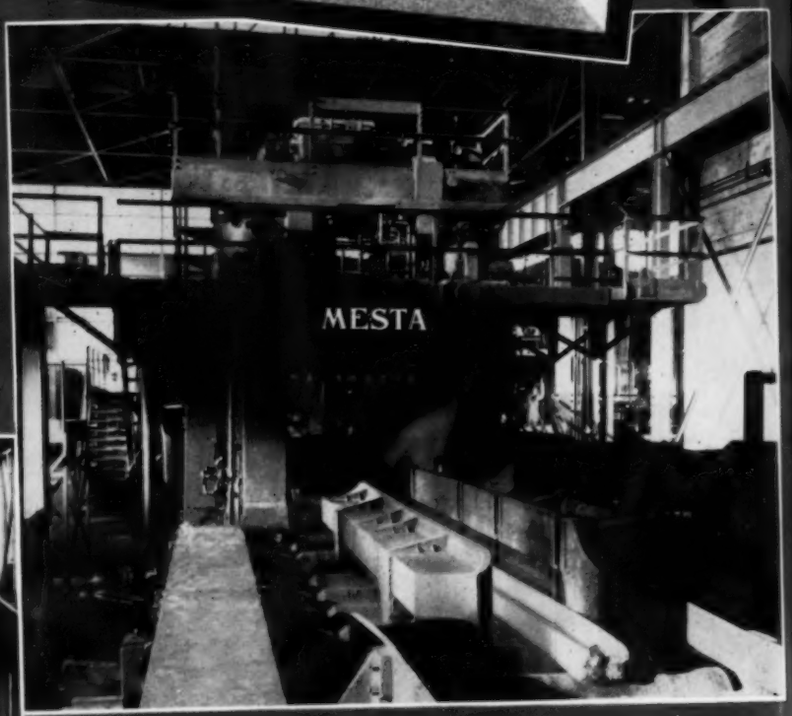
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

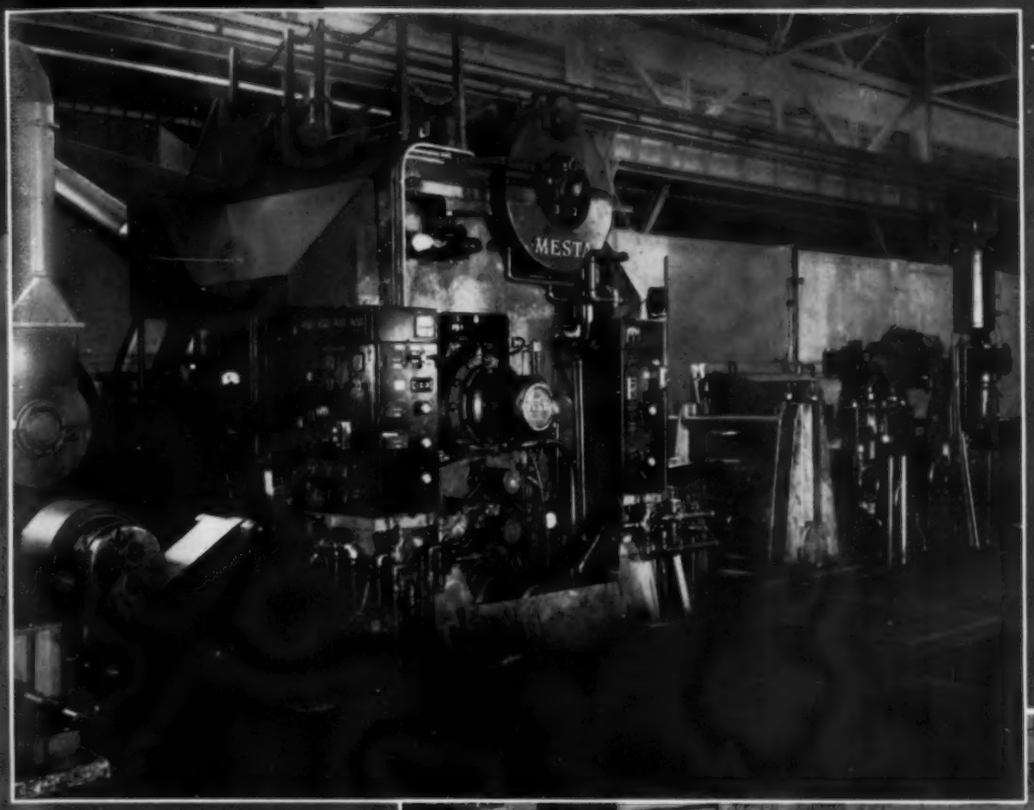
NOT JUST A BALL — NOT JUST A ROLLER — THE TIMKEN TAPERED ROLLER — BEARING TAKES RADIAL AND THRUST — LOADS OR ANY COMBINATION

Designed and Built by MESTA



MESTA 36" BLOOMING MILL

MESTA 18"—14"—10"
MERCHANT MILLS WITH PACK
ANNEALING COOLING BED
AND EQUIPMENT



MESTA 24" FOUR-HIGH
SINGLE STAND REVERSING
COLD MILL

MESTA 29" STRUCTURAL MILL
SHOWING TRAVELING
TILTING TABLE

for

KAISER STEEL CORPORATION

FONTANA, CALIFORNIA

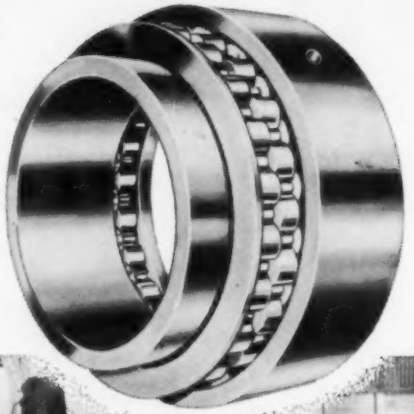
Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

Exceptional load capacity and heavy-duty operation of

ORANGE "STAGGERED" ROLLER BEARINGS

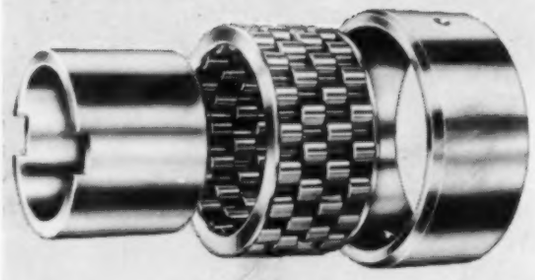


--proved by 10 years' Rugged Service in the Plate Mill at KAISER STEEL CORPORATION, FONTANA WORKS

Orange Staggered Roller Bearings are installed in the approach table in the two-high roughing stand at the Fontana Works, who report satisfactory experience with Orange bearings since the plant was originally constructed in 1943.

The unique staggered design of Orange Staggered Roller Bearings distributes the load over many short rollers, instead of a few full length rollers. This eliminates skewing tendencies of long rollers—provides closer centers for maximum supporting area—assures smooth, precision running due to uniform distribution of load—and results in longer bearing life and extra margin of safety for your installations.

Orange Staggered Roller Bearings are available in a full range of standard sizes, fully interchangeable with other bearings in complete unit or component parts. Engineering service and stocks in all industrial centers. Submit your problems to our engineering department.

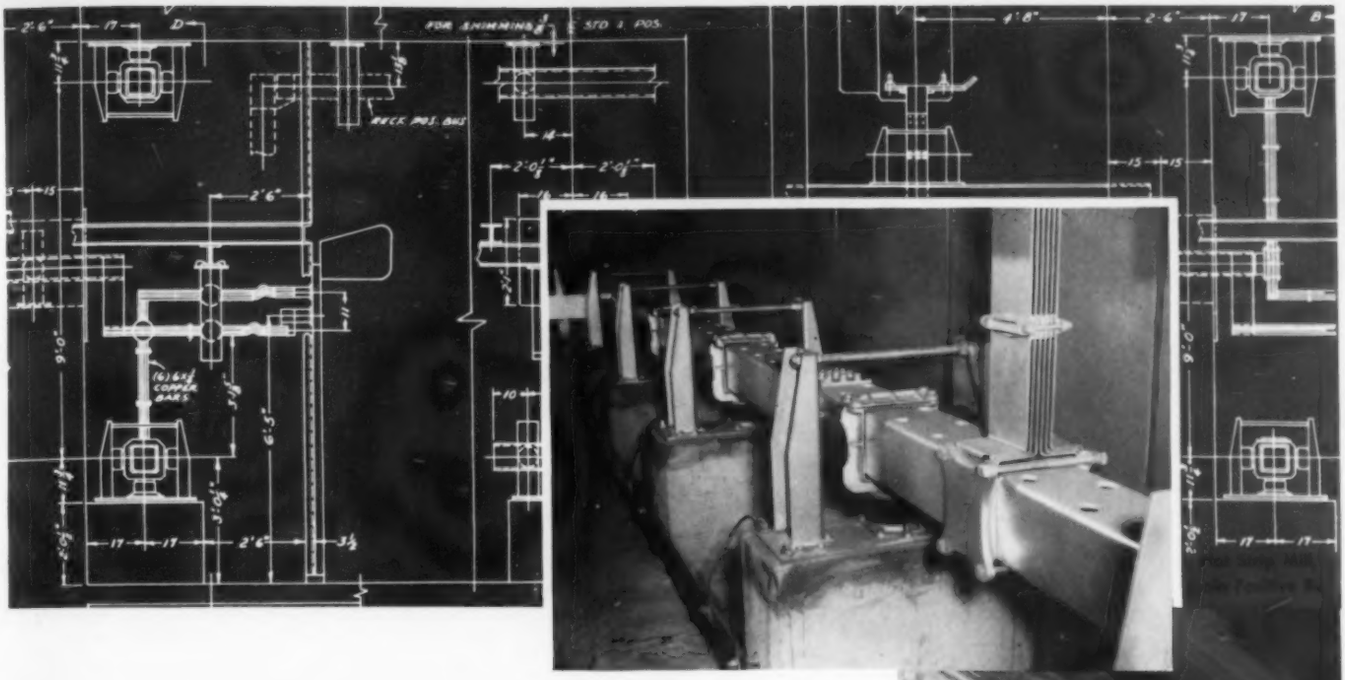


Shown are end views of an Orange "Staggered" Roller Bearing (upper) and a conventional roller bearing. Note how staggered roller design provides a multiplicity of contact points within the loaded zone.

ORANGE

Write for Engineering Data Book showing sizes, capacities, installation data, etc.

ORANGE ROLLER BEARING CO., INC., 571 Main Street, Orange, N. J.

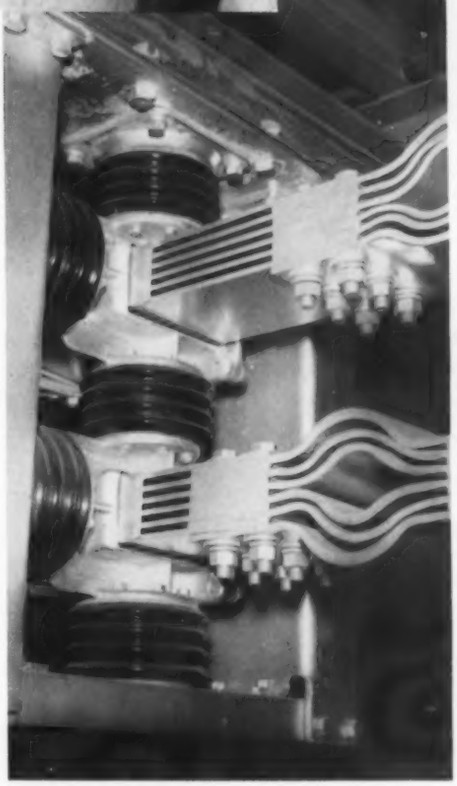


WEST COAST STEEL MILL INSTALLS DELTA-STAR REINFORCED BUS STRUCTURES

Kaiser Steel adds its name to the long list of steel mills throughout the United States who use Delta-Star Reinforced Bus Structures.

Careful engineering and fabrication assures a structure that can be depended upon to withstand the destructive forces resulting from short circuit current. Providing economy and security, these structures are designed and furnished complete to the last detail. Assemblies consist of heavy steel frames with oversize insulators used in compression; taking full advantage of their greatest strength.

Our engineers will be glad to discuss your bus problems and work out a layout to suit your special requirements. Prefabricated open or enclosed bus structures are available for aluminum or copper bars and tubing; structural and special shapes; indoor or outdoor service.



Vibration-free Connectors at Circuit Breakers and all other Terminals.

OTHER DELTA-STAR PRODUCTS
Used in Mills and Industrial Plants

- Crane Rail Supports
- Disconnecting Switches
- Terminators (Potheads)
- Plugs and Receptacles
- Spool Insulator Cable Supports
- Water Cooled Conductors and Fittings
- Interrupter Switches
- Disrupter Switches
- Bus and Cable Connectors
- Outdoor Substations

DELTA-STAR ELECTRIC DIVISION

H. K. PORTER COMPANY, INC.
OF PITTSBURGH
2437 FULTON STREET, CHICAGO 12, ILLINOIS
DISTRICT OFFICES IN PRINCIPAL CITIES

AT KAISER FONTANA STEEL PLANT

FOUR COMPLETE I-R BLOWER PLANTS*

with a total rated capacity of 350,000 cubic feet of charging air per minute

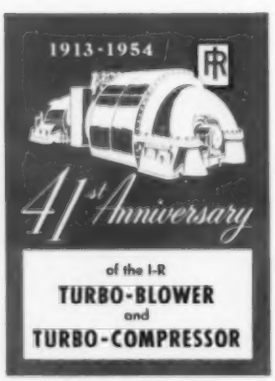
**Ingersoll-Rand Turbo-Blowers driven by I-R Steam Turbines and served by I-R Surface Condensers, Air Ejectors and Condensate Pumps*

Two of the four Ingersoll-Rand Turbo-Blowers installed in the furnace blowing room of the Kaiser Fontana Steel Plant.

It takes a lot of air to keep the blast furnaces burning at the huge Kaiser plant. And *all of it* is supplied by Ingersoll-Rand Turbo-Blowers.

The I-R blower equipment at the Fontana Plant includes two 100,000 cfm and two 75,000 cfm steam turbine driven Turbo-Blowers, each served by I-R rectangular surface condensers, steam-jet air ejectors and condensate pumps. These complete I-R Blower Plants, with all elements designed to work together as a unit, provide the *maximum dependability* for continuous heavy-duty service, year after year.

When it comes to blast furnace blowing, Ingersoll-Rand's experience is unequalled. That's why I-R blast furnace turbo-blowers are first choice in America's steel plants. Your nearest Ingersoll-Rand engineer will be glad to tell you more about I-R turbo-blowers. Ask for your copy of catalog 8258.



OTHER I-R EQUIPMENT SERVING THE KAISER PLANT AND EAGLE MOUNTAIN IRON ORE MINE

- Gas-Engine-Driven Compressors
- Electric Driven Compressors
- Centrifugal Pumps
- Wagon Drills
- Air Tools
- Paving Breakers

Ingersoll-Rand

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TREADWELL

MIXER TYPE HOT METAL CAR

168 NET TON CAPACITY

IN SERVICE AT

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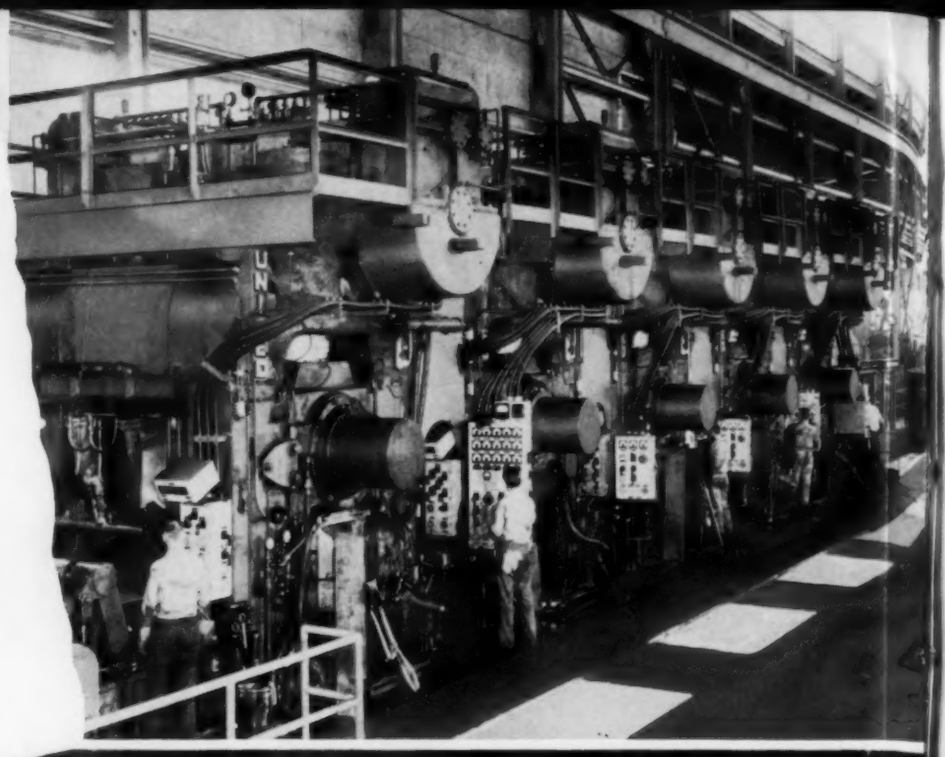
HEAD, WRIGHTSON, LTD., Thornaby on Tees, England

21" & 52" x 48", 5-Stand, 4-High, Cold Mill

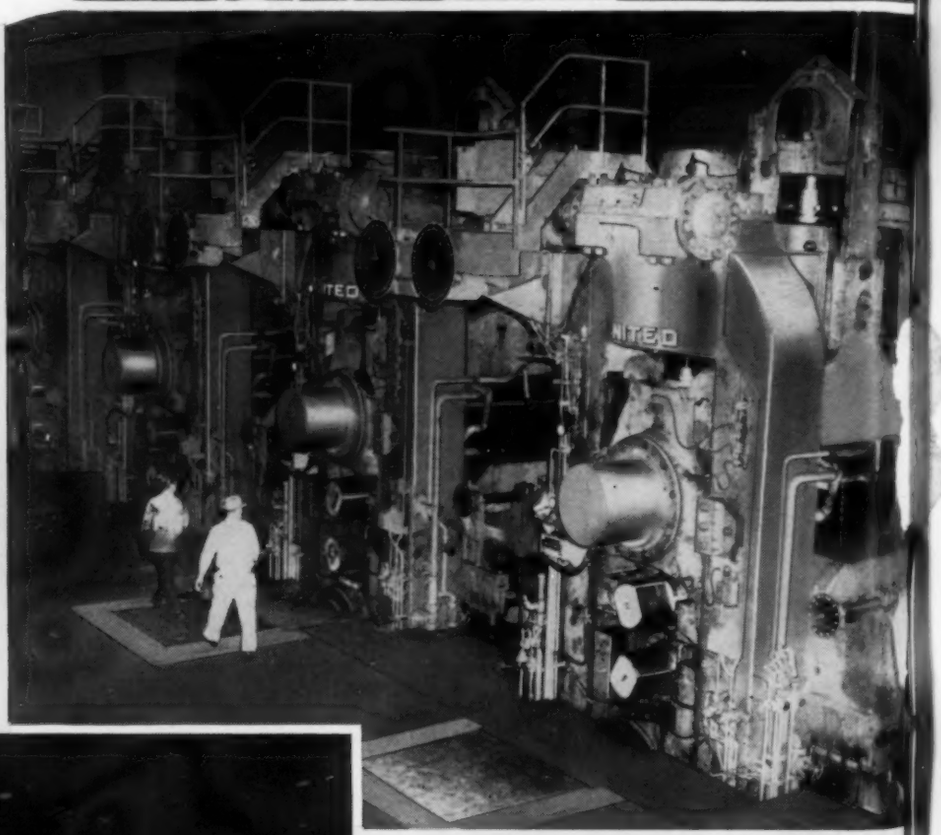


UNITED® MILLS

Designed and Built for

KAISER STEEL CORPORATION

Fontana Works
California



UNITED

ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh • Vandergrift • New Castle
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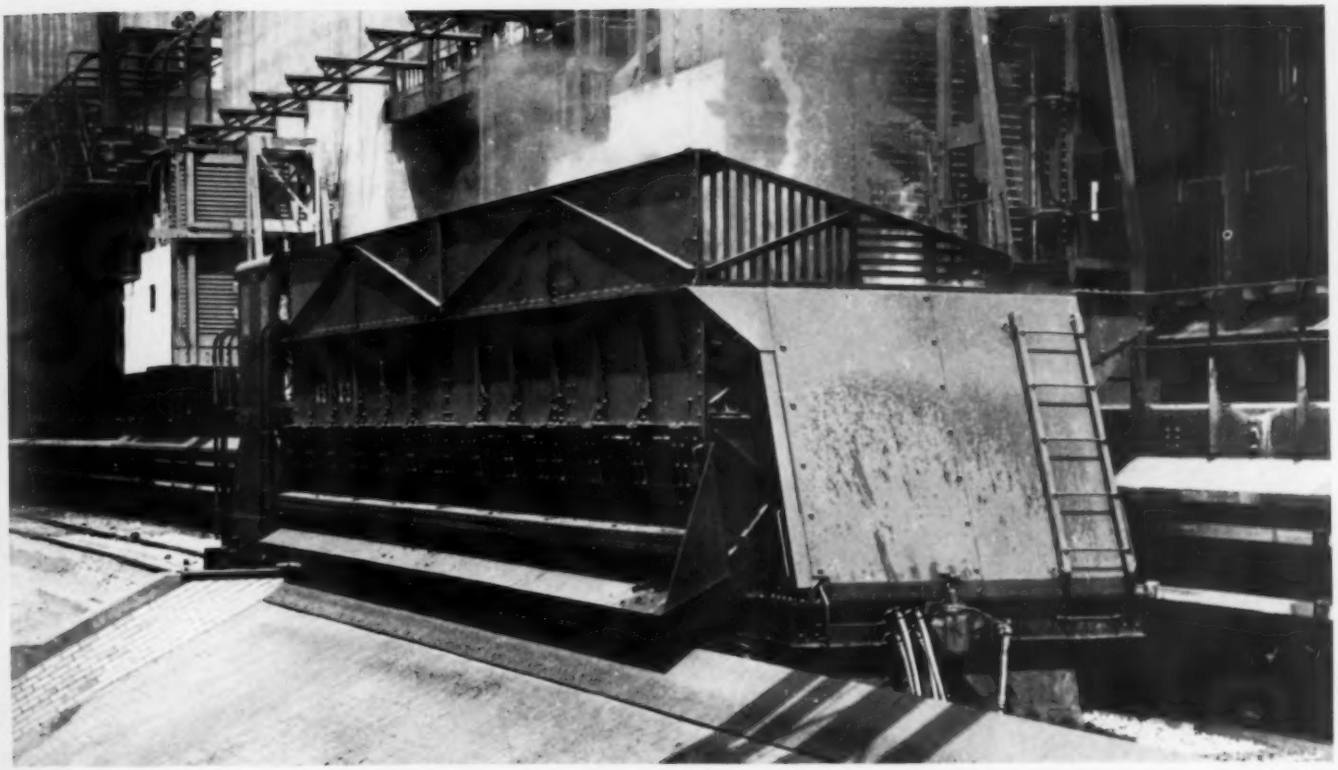
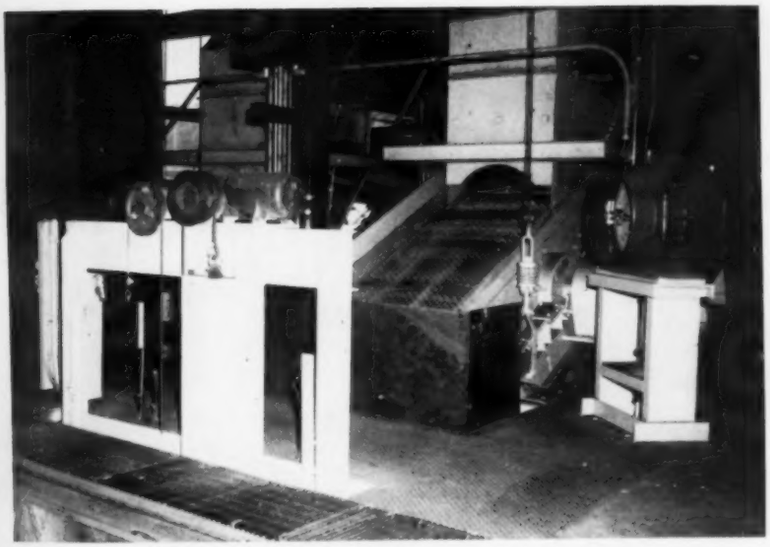
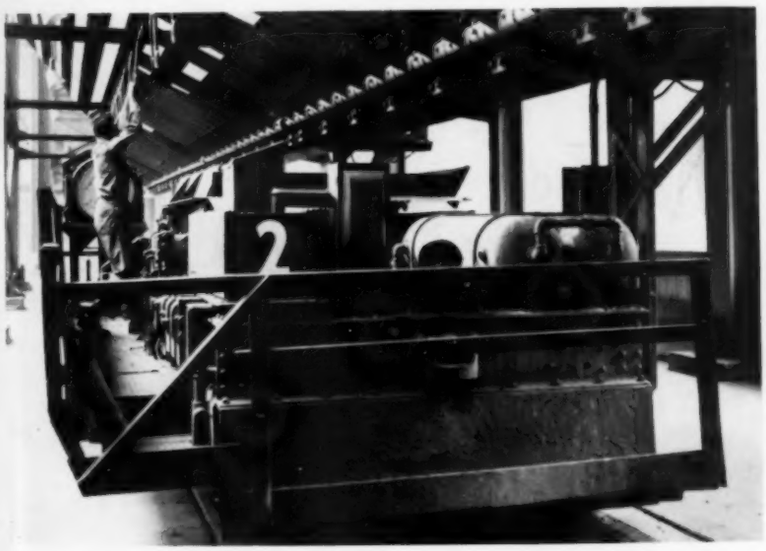
27" & 54" x 86", 4-High, Hot Strip Mill

44", 4-High and 2-High, 2-Stand Temper Mill







ATLAS SERVES KAISER AT FONTANA

TOP—ATLAS COKE QUENCHER receives burden from oven.

CENTER—AUTOMATIC COKE WEIGHING INDICATING DIAL SCALE with type printing recorder.

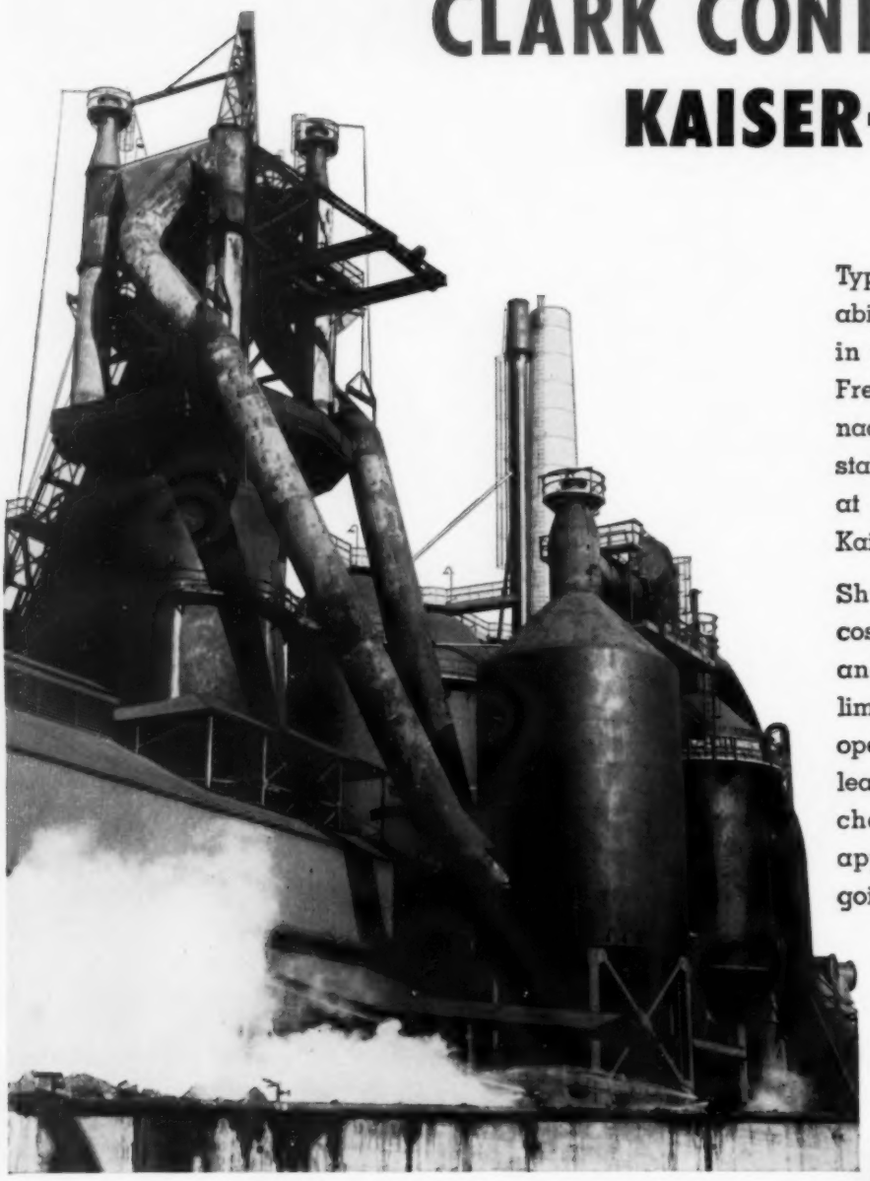
BOTTOM—ATLAS SCALE CAR receiving charging burden at stockhouse.

THE ATLAS CAR & MFG. CO.

1100 IVANHOE RD. · CLEVELAND 10, OHIO

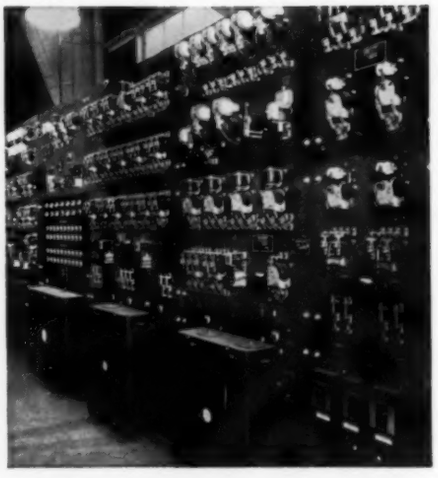
Engineers and Manufacturers

CLARK CONTROL at KAISER-FONTANA



Typical of the accuracy and depena ability required of electrical controls in industrial automation are the Freyn Design, Clark-built blast furnace charging control systems installed for the 3 huge blast furnaces at the Fontana, California plant of Kaiser Steel Corporation.

Shut-downs at blast furnaces are costly. Proper sequence charging and distribution of coke, ore and limestone are vital to their continuous operation. Koppers-Freyn Engineers, leading designers of blast furnace charging controls, specified Clark-apparatus to keep these furnaces going 24 hours per day.



Clark engineered controls are the "mechanical brains" for countless automatic machines and processing lines in all types of industry. Clark engineers will gladly show you how best to solve your control problems.

Clark Control Panel for Freyn Design blast furnace charging control at the Kaiser-Fontana plant.

ENGINEERED ELECTRICAL CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND STREET, CLEVELAND 10, OHIO

Announcing

F&Ym CONTINUOUS STRIP PICKLING LINE

NEW • EFFICIENT • ECONOMICAL

Complete line equipment with latest improved operating features. Maximum volume production with minimum floor space requirements.

If you are interested in a new installation or improving your present equipment why not investigate the Youngstown Line!

these features

- ☐ Coil Box with Strip Opener.
- ☐ Triple Processor with Roller Leveller.
- ☐ Flash Welding and Mechanical Stitching.
- ☐ Single Cycle Up-Cut Shears.
- ☐ Heavy Duty Rubber Covered, Brick Lined Steel Tanks.
- ☐ Magnetic Loop Control for Acid Tanks.
- ☐ Fume Exhaust System—Roto Clone Scrubber.
- ☐ Automatic Control System for Temperature and Acid Proportioning.
- ☐ Side Trimmer with Scrap Cutting or Balling.
- ☐ Up-Coiler with Strip Oiling System.
- ☐ Entry and Exit Coil Conveyors.

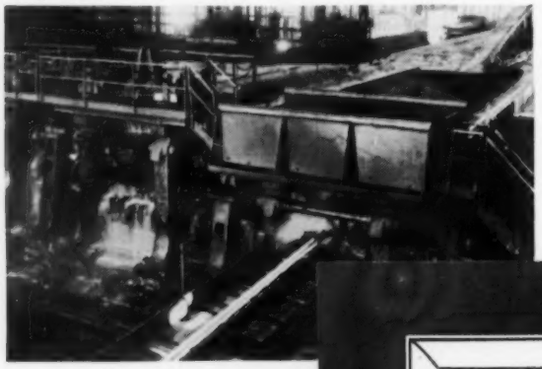
The Youngstown Foundry & Machine Co. F&Ym

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

9

KAISER STEEL CORPORATION, FONTANA, CALIF. — *28" Structural Mill. Another one of the more than 11,000 successfully completed electrical contracting jobs engaged in by Fischbach & Moore in the past 35 years.*



Another Electrical Installation by

FISCHBACH AND MOORE

INCORPORATED

"Symbol of Confidence..."

Our association with the Kaiser Steel Corporation's Fontana, California Plant is further proof of the confidence American Industry has for our experience, integrity and facilities.

FISCHBACH AND MOORE

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ELECTRICAL CONTRACTORS

FROM COAST TO COAST *An organization that has to its credit every conceivable type of electrical installation.*

COMPLETE ORGANIZATIONS AT: *New York, Atlanta, Dallas, Houston, Los Angeles, San Francisco, Chicago, Detroit, Pittsburgh, Phoenix.*

Aetna-Standard *Salutes* Kaiser Steel

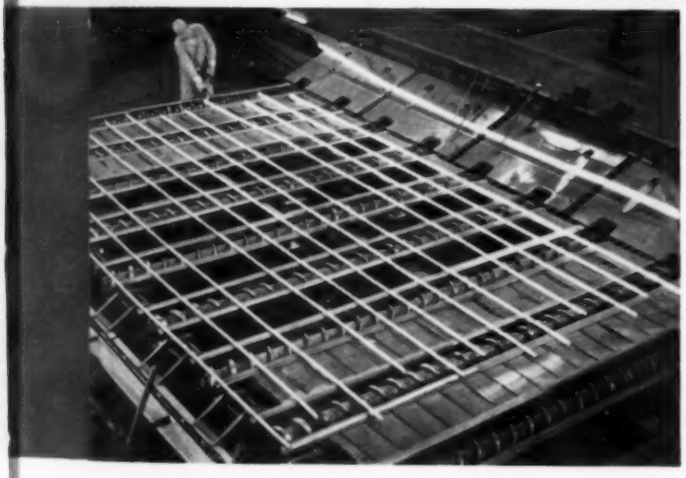
FONTANA WORKS

It is always a pleasure to salute a good and satisfied customer. For Kaiser-Fontana, Aetna-Standard designed and built much equipment, including . . . a Continuous Butt Weld Pipe Mill; Tin Plate Shearing and Classifying Line; Pipe Galvanizing Plant.

Aetna-Standard appreciates this confidence and the confidence expressed by other steel producers in Aetna Flat Rolled Finishing Equipment, Continuous Coating Lines, Pipe and Tube Mills, Drawbenches, Rolls and other production machinery.

1 Forming and Welding Mill of Continuous Butt Weld Pipe Mill.

2 After galvanizing, pipe moves to this bed for cooling.



3 Cut lengths from Rotary Flying Hot Saw cool here.

THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Aetna-Standard

PLANTS IN WARREN, OHIO • ELLWOOD CITY, PENNSYLVANIA

GOOD EQUIPMENT BRINGS DOWN PRODUCTION COSTS

SUBSIDIARY and ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England — Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.
Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.
M. Castellvi, Inc., New York, N. Y. — Mexico, Central and South America.
Societe de Constructions de Montbard, Paris, France — France, Belgium, Holland, Luxembourg, Switzerland.
Demag Aktiengesellschaft, Duisburg, Germany — Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.
Compagnia Italiana Forme Acciaio, Milano, Italy — Italy.
Aetna-Japan Company, Ltd., Tokyo, Japan — Japan.
Hale & Kullgren, Inc., Akron, Ohio — Representative for the Rubber Industry.
Standard Engineering Company, Ellwood City, Pa.
Trans-World Traders, Pittsburgh, Pa.

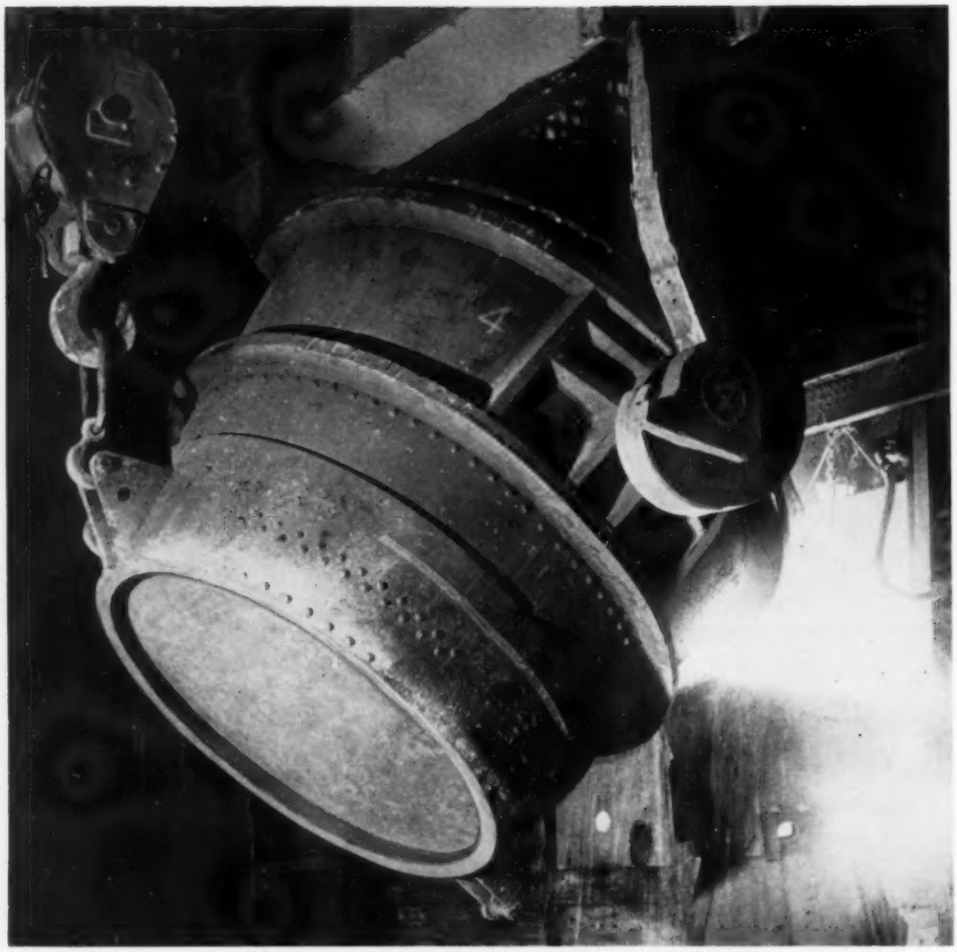
Designers and Builders to the Ferrous, Non-Ferrous, Leather, Rubber, and Plastic Industries

TREADWELL

LADLES

FOR

OPEN HEARTH, BESSEMER ELECTRIC FURNACE AND FOUNDRY SERVICE



90 NET TON OPEN HEARTH TRANSFER LADLE

IN USE AT

KAISER STEEL CORPORATION

FONTANA, CALIFORNIA

TREADWELL CONSTRUCTION COMPANY

MIDLAND, PENNA.

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CHICAGO 4, ILL.
CEntral 6-6784

140 CEDAR STREET
NEW YORK 6, N. Y.
WOrth 4-2244

1526 FARMERS BANK BLDG
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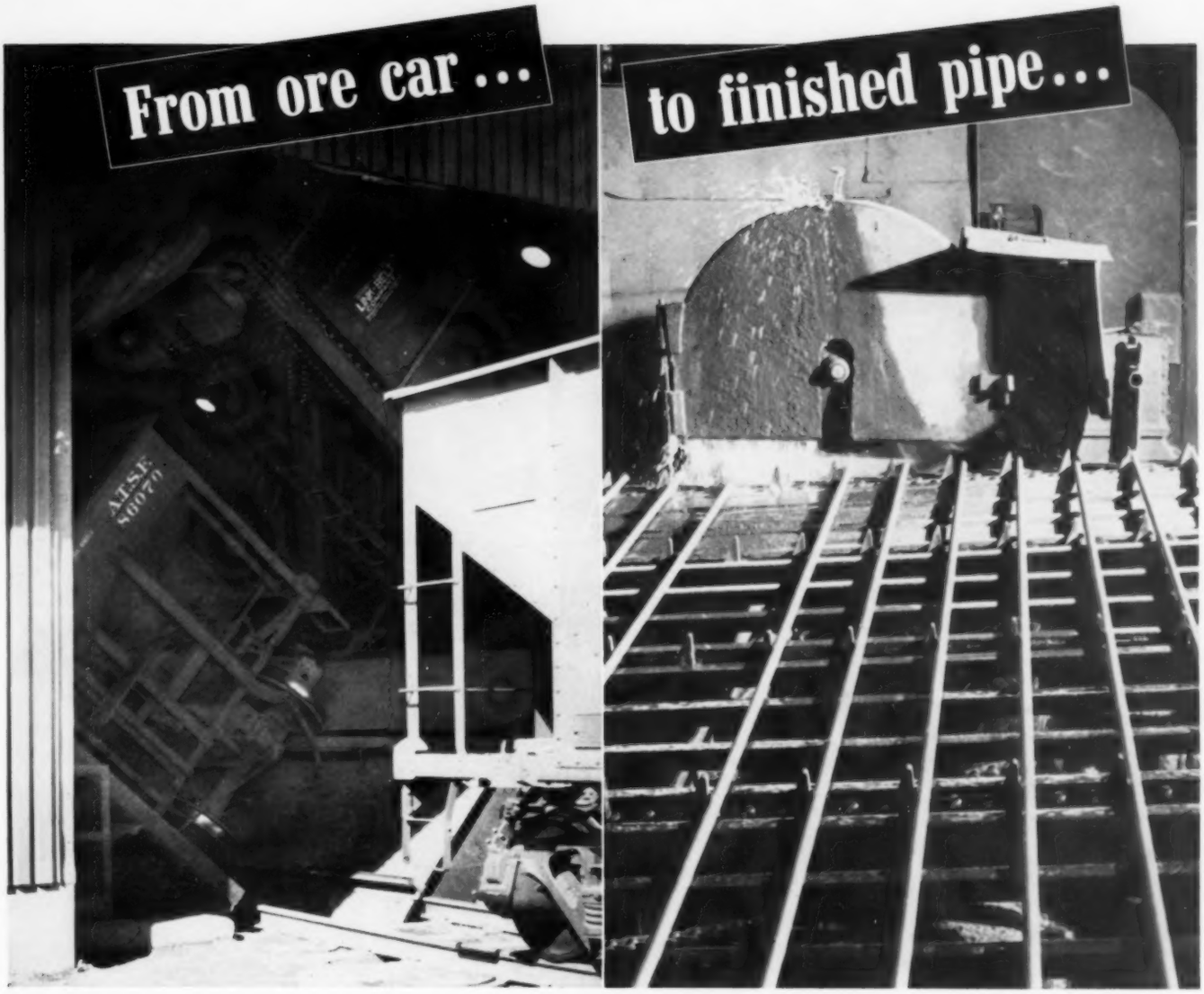
ATlantic 1-5888



UP TO 20 RAILROAD CARS PER HOUR can be unloaded by this Link-Belt Rotary Car Dumper at Kaiser's Fontana plant.

PIPE COOLING is accomplished at Fontana on twelve endless strands of Link-Belt Class H pintle chain with attachments.

LINK-BELT helps Kaiser Steel move materials

As in so many of the nation's steel mills, Link-Belt equipment provides efficient, high-capacity handling at the Fontana plant of Kaiser Steel Corporation. In addition to the rotary car dumper and pipe cooling rack pictured above, Fontana has also called on Link-Belt for the following equipment:

- **Four coil conveyors** handling coils to and from tinplate preparation line, from temper mill and feeding into shearing line.
- **Belt conveyor equipment** for coke wharf.
- **Three skip hoists** to handle slag and refuse in clean out pits around blast furnaces.
- **A second rotary car dumper** complete with car haul and other auxiliaries.

It's the same story in mills everywhere. Link-Belt conveying systems provide fast, safe, economical handling of steel in every form. Our engineers will work with your own engineers, consultants and builders of mill and process equipment—help you get the materials handling that's best for your needs. A call to your nearby Link-Belt office will put the facilities of this nation-wide organization to work for you.

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LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

TSP Screwdown Screws on 36" Blooming Mill produced 2,150,000 tons to date and hardly worn.

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"Tool Steel Process" Gears, Pinions, Rolls, Wheels, Screwdown Screws, etc., installed at Kaiser Steel Corp. plant at Fontana, Calif., a few of which we picture here, are again proving that TSP parts last many times longer in the same service than competitive products. In every case at Kaiser Steel, TSP service records on file show dollar savings in maintenance and downtime.

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HERE'S WHY: TSP products are hardened by our special process. The file hard surface to full depth of permissible wear gives maximum life. The core, refined for toughness and ductility gives maximum strength.

You receive an absolutely positive written guarantee that TSP products will give a longer life in the same service than any other product.

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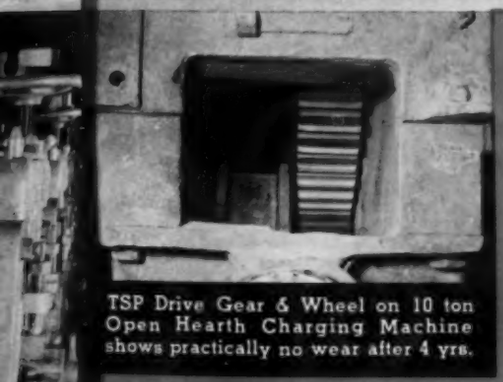
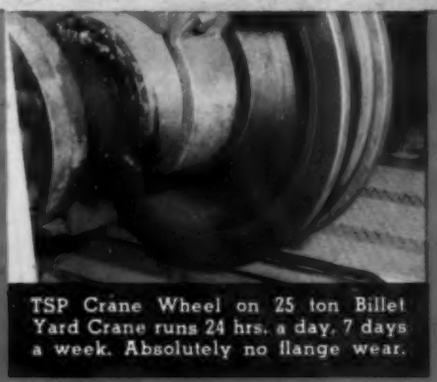
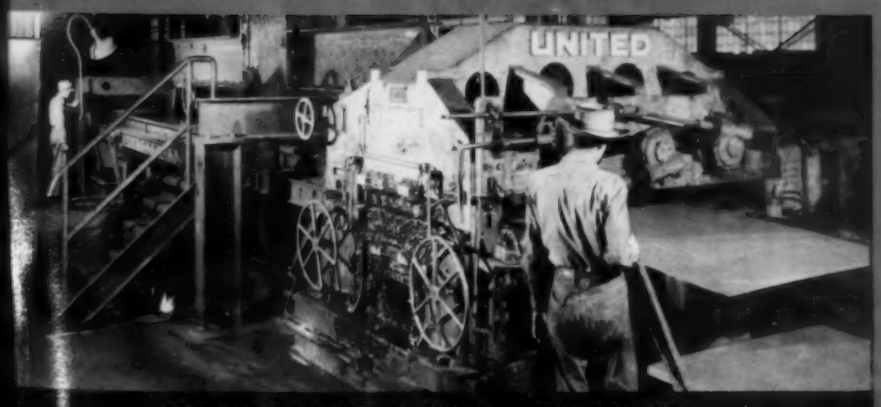


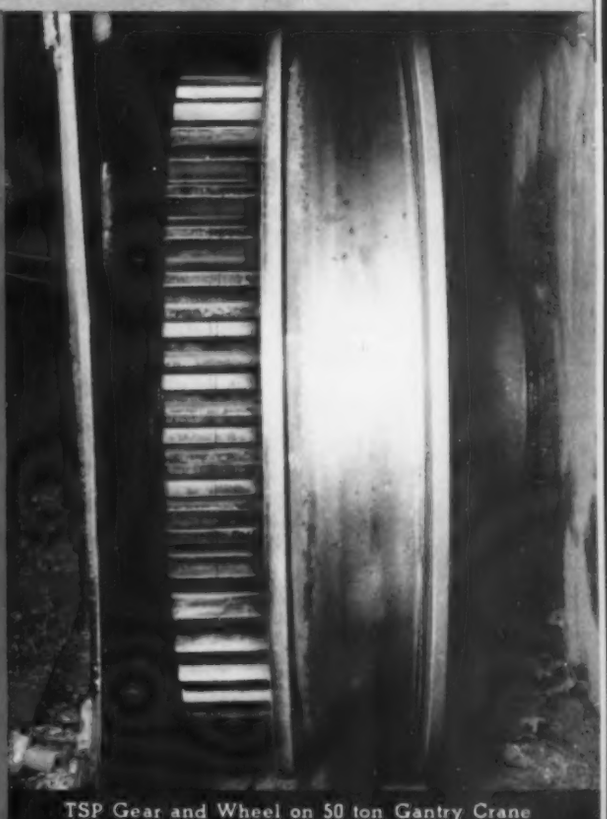
TSP Drive Gear & Wheel on 10 ton Open Hearth Charging Machine shows practically no wear after 4 yrs.



TSP Crane Wheel on 25 ton Billet Yard Crane runs 24 hrs. a day, 7 days a week. Absolutely no flange wear.



TSP Leveller and Pinch Rolls on a United Leveller



TSP Gear and Wheel on 50 ton Gantry Crane showing no wear after 5 years.

909

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Wellman charging machines

efficiently serve open-hearth furnaces at

Kaiser Steel

● At the Fontana, California plant of Kaiser Steel Corporation, three 10-ton Wellman Low-Type Open-Hearth Charging Machines are on the job. One of these is shown above.

Steel mills have looked to Wellman for engineering assistance and efficient equipment for more than half a century. Find out how modernization with Wellman equipment can lower your costs.

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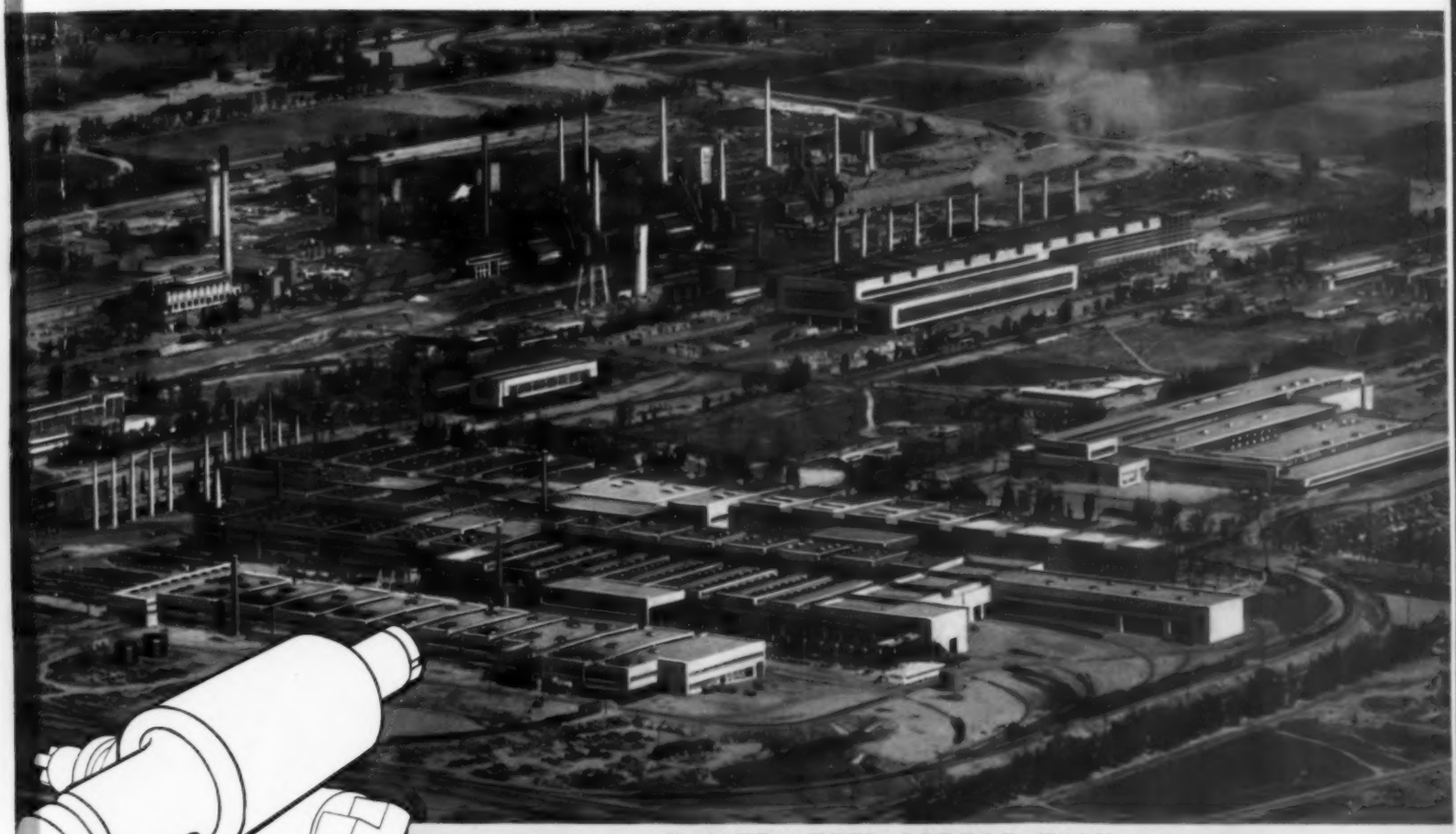
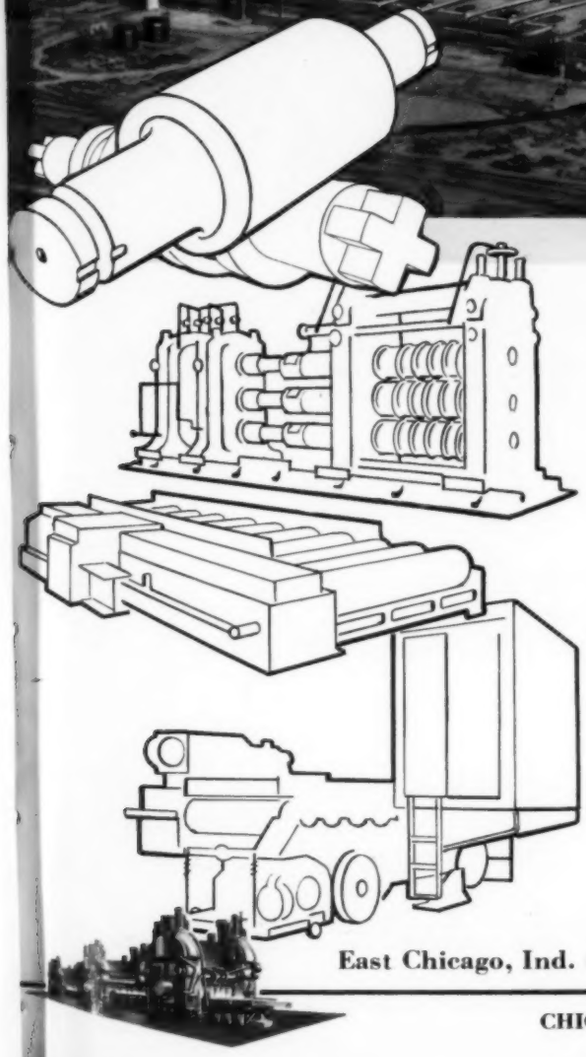


KAISER STEEL CORPORATION FONTANA, CAL.



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Yes, since the beginning of the Fontana Works of Kaiser Steel Corporation, Continental has been a regular supplier of mill equipment and rolls. In more recent years, Continental has been prominent in the plant's modernization program.

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Fontana statistics warm the hearts of steelmen

All facilities of Kaiser Steel's completely integrated steel mill – twelfth largest in the United States – were designed and constructed by Kaiser Engineers:

blast furnaces... open hearths... structural mill... hot strip mill... sinter plant... merchant mill... electric and continuous weld pipe mills... electrolytic tinning line... water treatment... in-plant railroads... coal and iron ore mining facilities... in-plant distribution of purchased power.

call or wire *Kaiser Engineers for economical solutions of your design and construction problems.*

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ENGINEERS K CONTRACTORS

KAISER ENGINEERS DIVISION OF HENRY J. KAISER COMPANY, HOME OFFICE, KAISER BUILDING, OAKLAND 12, CALIFORNIA; NEW YORK, PITTSBURGH, LOS ANGELES, WASHINGTON, D.C. (CABLE: KAISENGS) • KAISER ENGINEERS DIVISION OF HENRY J. KAISER COMPANY (Canada) LTD., MONTREAL

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... *correct* OHMIC VALUES

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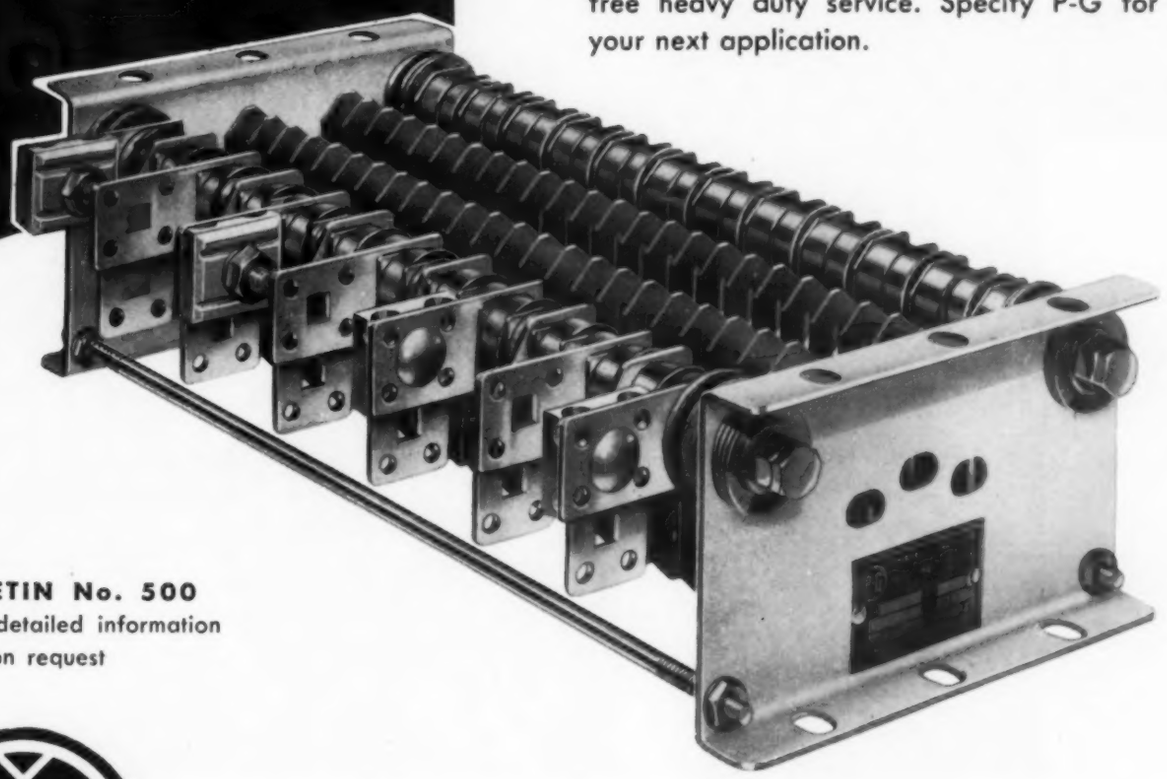
Use resistance grids punched from many gages of resistor steel. Thus it is easier for P-G to meet correct ohmic values and still furnish the capacities necessary for each job. Ability to meet both requirements is assurance of accurate control with full protection for your electrical equipment. All steel construction, mica insulation, with provision for expansion and ample ventilation give that extra stamina needed for trouble-free heavy duty service. Specify P-G for your next application.



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The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

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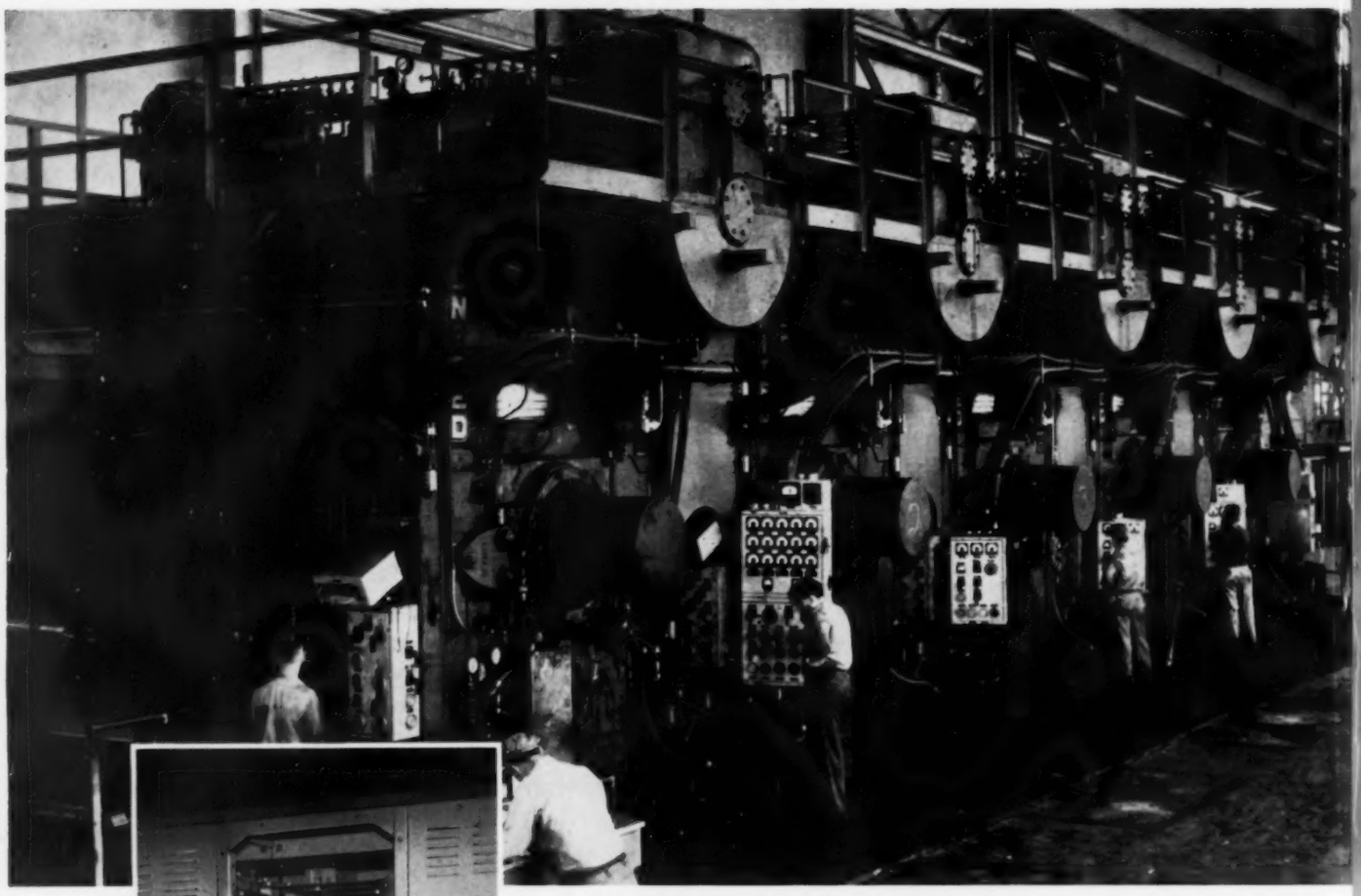
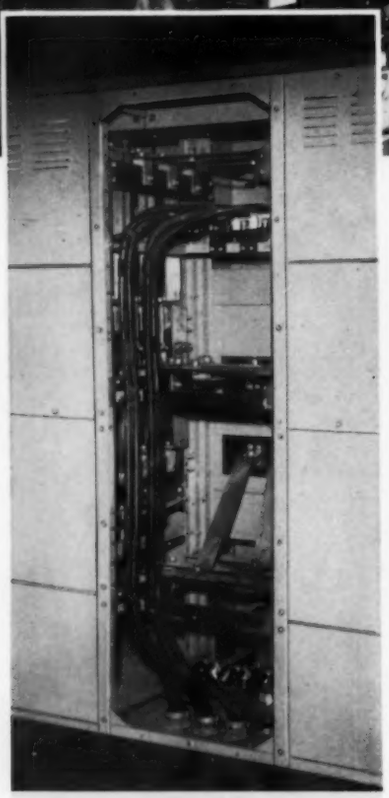
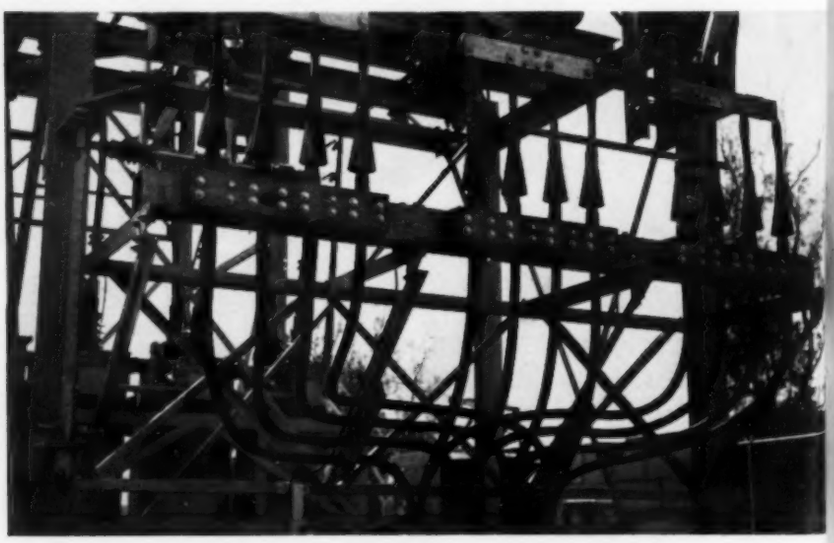
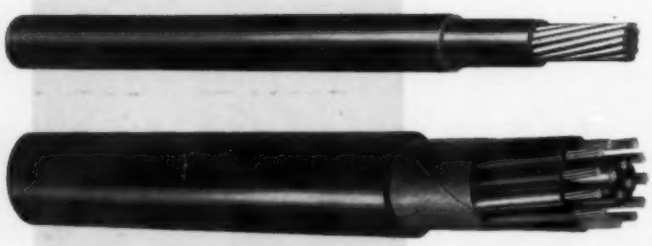


Cable dependability is of utmost importance to this five-stand cold reduction mill. Cable must be able to withstand high-operating temperatures, corrosive fumes from acid pickling line, oils and abrasives.



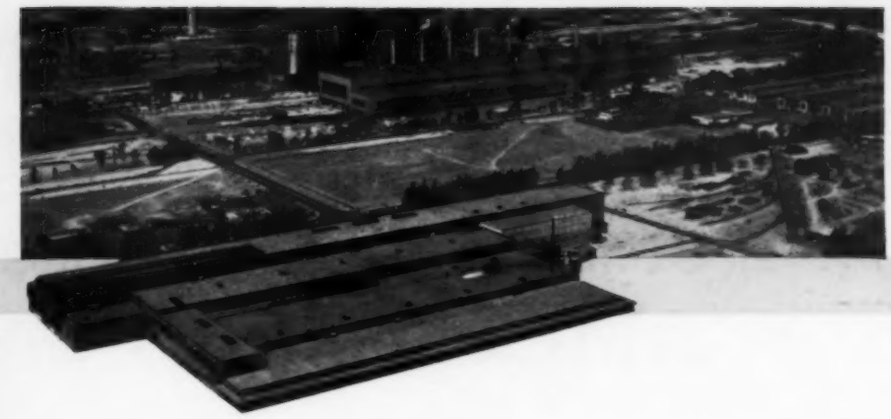


Outdoor connections at switch yard. Note manually prepared terminals.



The 600 volt cable for motor connections and single conductor control cable was RoMarine-RoPrene, style RR-D. All sizes from No. 12 to 1000 CM style RR-D were used for this service.

Multi-conductor control cable in this installation is RoLene (polyethylene) insulated and RoPrene (polyvinyl chloride) sheathed, described by Rome Cable specification CT-2.



Recently built Kaiser Steel Tin Plate Mill (left foreground), Fontana, California. Capacity is 200,000 tons of tin plate per year.

Electrical Contractor:
Kaiser Engineers, Inc.

How Kaiser Steel licked 3 tough cable problems all at once

In selecting power cables for 6.9 KV circuits at its new Fontana Tin Plate Mill, Kaiser Steel Corporation faced three knotty problems:

First, the hazard of acid and alkali corrosion was severe.

Second, the threat of electrolytic action was more than a possibility.

Third, termination and splicing costs were important factors.

Kaiser's choice for this service fell to single conductor, 500,000 CM Rome RoZone-RoPrene shielded power cable, insulated for 9 KV. Two sets were installed to connect the main substation with two 6,900 volt busses in the tin mill proper. Total connected load to the busses was 19,000 HP of M-G motors and 14,250 KVA of transformers.

Why RoZone-RoPrene

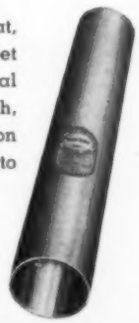
RoZone insulated, RoPrene sheathed cables offer maximum protection against acids, alkalies, oils, greases, moisture, heat, sunlight, and flame. They are non-metallic sheathed and require no lead sheaths with subsequent cathodic protection against electrolysis. Their RoZone (premium quality oil base) insulation provides exceptional resistance to corona action and ozone cutting.

Simple manual terminations eliminate the need for regular wiped potheads. Standard splicing kits only are needed; no costly wiped joints. And the smooth surface of the RoPrene (Neoprene compound) sheath makes for easy working and pulling through conduits and junction boxes.

HELPFUL INFORMATION—Whether your electrical requirements involve special cable designs to meet severe service conditions or simple home wiring, consider the advantages Rome products offer from the standpoint of price and quality. For information that you may find immediately useful, send for the *Rome Power and Control Cable Catalog* illustrated below.

500,000 CM, single conductor shielded, RoZone-RoPrene power cable, rated at 9 KV.

To give wires and cables added protection against heat, moisture, corrosion and abrasion, several thousand feet are encased in Rome • EMT. This is a superior electrical metallic tubing, electrically welded for extra strength, with an electrogalvanized exterior surface for protection against corrosion and a mirror-smooth interior surface to prevent cable injury.



You'll get a wealth of helpful information from the Rome Power and Control Cable Catalog. It contains 65 pages of illustrated information, specification and test data on all Rome power and control cables and on famous Rome insulations. Mail the coupon for your copy today.

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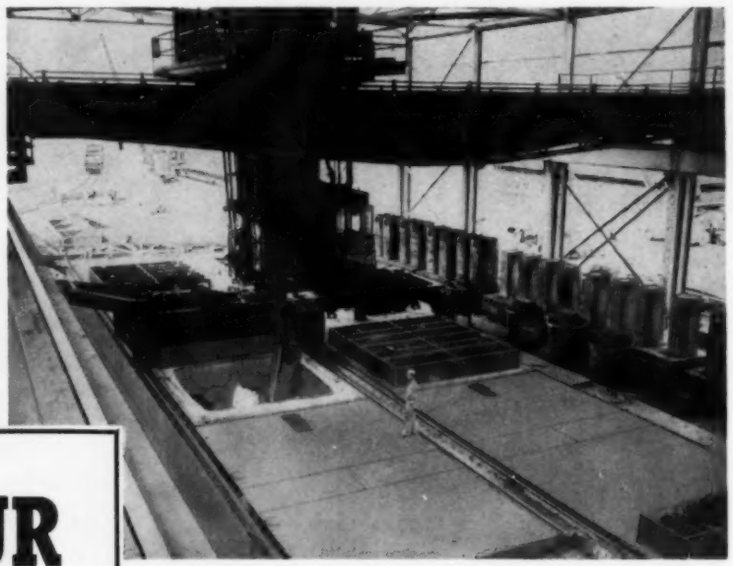
5th. REPEAT ORDER

The progressive KAISER STEEL organization chooses AMCO soaking pits again



TWENTY-FOUR

Soaking pits now in operation at the Fontana plant of KAISER STEEL perform the gigantic task of heating steel ingots of top quality for production of pipe, plate, tin plate, structurals, etc.

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CORPORATION
CHAMBER OF COMMERCE BUILDING — PITTSBURGH 19, PA., U. S. A.

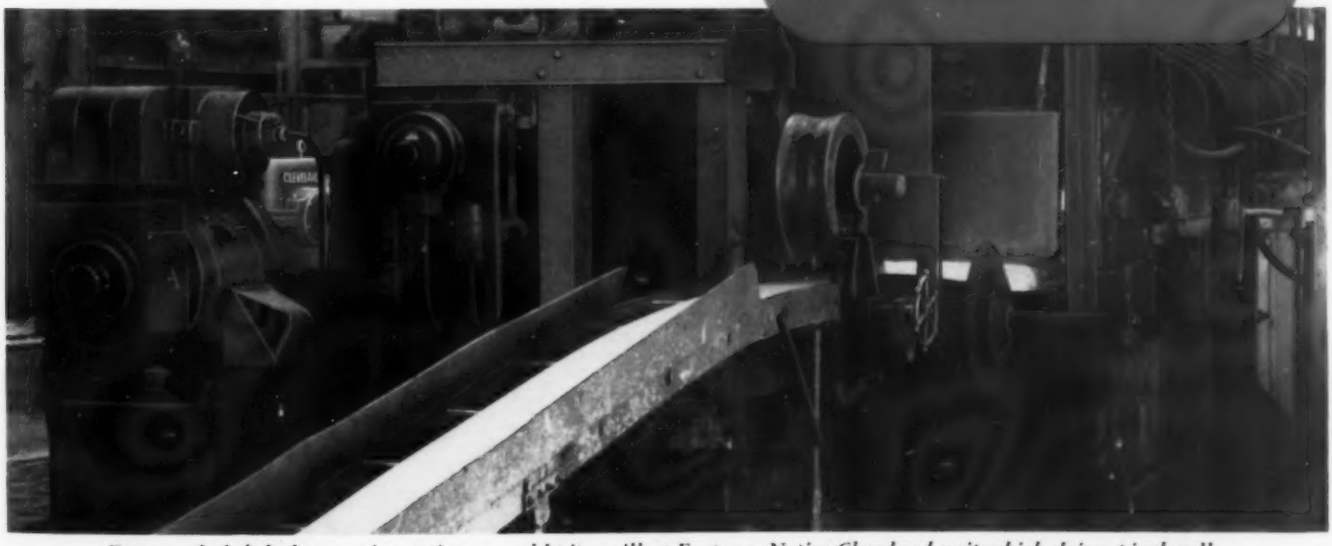
Fontana Works of Kaiser Steel Corporation.

It's CLEVELAND drives for rugged steel mill service

THROUGHOUT the Kaiser Fontana Works, you'll find space-saving Cleveland worm gear speed reducers driving press feeder tables, down edgers, roller tables, ingot buggies, slab pushers, conveyors and other vital equipment.

Clevelands feature long-wearing case-hardened steel worms in perfect mesh with nickel-bronze gears. ALL units are run in and pre-tested under load before delivery. This explains why Clevelands have the reputation of outlasting the machines they drive. The Cleveland Worm and Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.



Entry end of skelp furnace in continuous weld pipe mill at Fontana. Notice Cleveland unit which drives pinch rolls.

FARVAL at Kaiser's Fontana Works protects 8,356 bearings

All bearings on these furnace tops are lubricated automatically and safely from a Farval central pumping station.

SINCE World War II, 245 Farval centralized systems of lubrication have been installed to protect 8,356 bearings at Kaiser's Fontana Works. Here, as in hundreds of other steel mills and metalworking plants throughout the country, Farval brings management important economies. These include large savings in oiling labor, lubricant consumption and increased bearing life. Most important of all, Farval lubricates while machines are operating, eliminating downtime for oiling. By keeping equipment steadily at work, Farval increases production.

Actually, Farval is not new to Fontana. During the war, Farval proved its worth on heavy equipment like this 5-stand 4-high Cold Mill (below). The increase in *Farvalized* equipment at this plant testifies to its effectiveness.

Wherever you go in the Steel Industry, you'll find Farval at work delivering oil or grease to bearings, in exact quantities, as often as desired.

The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

FARVALIZED EQUIPMENT AT FONTANA *(Since 1945)*

	Type Systems	No. of Bearings
Cranes	67-Manual	1,480
Blast Furnace	2-Automatic	393
Open Hearth Furnace	1-Manual	83
Furnace Approach & Entry Tables	3-Manual	158
Slab & Billet Transfer Tables	4-Manual	131
Ingot Transfer Cars	16-Automatic & Manual	256
86" Hot Strip Mill	7-Automatic & Manual	1,032
Temper Pass Mill	3-Automatic	275
14" Merchant Mill	5-Manual	168
2-High Skin Pass Mill	5-Automatic	213
4-High Reversing Cold Mill	1-Automatic	80
Coiling Equipment	5-Automatic & Manual	305
Multiple Pipe Testing Bench	1-Manual	51
90" Sheet Processor	1-Manual	83
Entry & Drive Bridle	2-Manual	40
Shearing Equipment	11-Automatic & Manual	270
Levelling Equipment	8-Automatic & Manual	296
Conveyors	6-Manual	111
Fretz-Moon Tube Mill	11-Automatic & Manual	564
Slab Pushers & Pilers	5-Manual	91
20" Semi-Continuous Strip Pickler	2-Manual	68

This 21″ x 53″ x 44″ 5-stand 4-high Cold Mill is typical of the heavy equipment protected by Farval. Dualine valves deliver lubricant to all bearings, no matter where located. Indicators at bearings show that each valve has functioned.

GROWTH POSSIBILITIES OF ELECTRIC FURNACE CARBON STEEL

By WILLARD C. WHEELER
Management Consultant
New York, N. Y.

. . . . all available clues indicate that the electric furnace will become a much more important factor in the production of carbon steel . . . .

▲ THE writer makes no pretensions as to technical knowledge of steel processes and practices. Neither is he the champion of any process, practice or interest. The only authority he can claim is in the field of analyzing trends affecting the economics of business and in projecting those trends so as to put management on notice regarding the probable conditions under which they will operate in the future.

What the writer is about to discuss is such an analysis of the possibilities of the growth of carbon steel production in the electric furnace based upon data for the production of steel ingots by all processes as published by the American Iron & Steel Institute. The methods used are somewhat unique and have been developed in professional association with others. The conclusions are exclusively those of the writer.

To clear the air and to provide a focal point for what follows, let the writer state his final figures at the outset. Electric furnace carbon steel production is following the general path of many other processes and products which have been similarly analyzed. It will be exceptional only if it does not continue to do so. This path will lead electric furnace carbon steel ingots to a tonnage equal to 30 per cent of total carbon steel ingots by 1975 or 40,000,000 tons plus or minus 10 per cent.

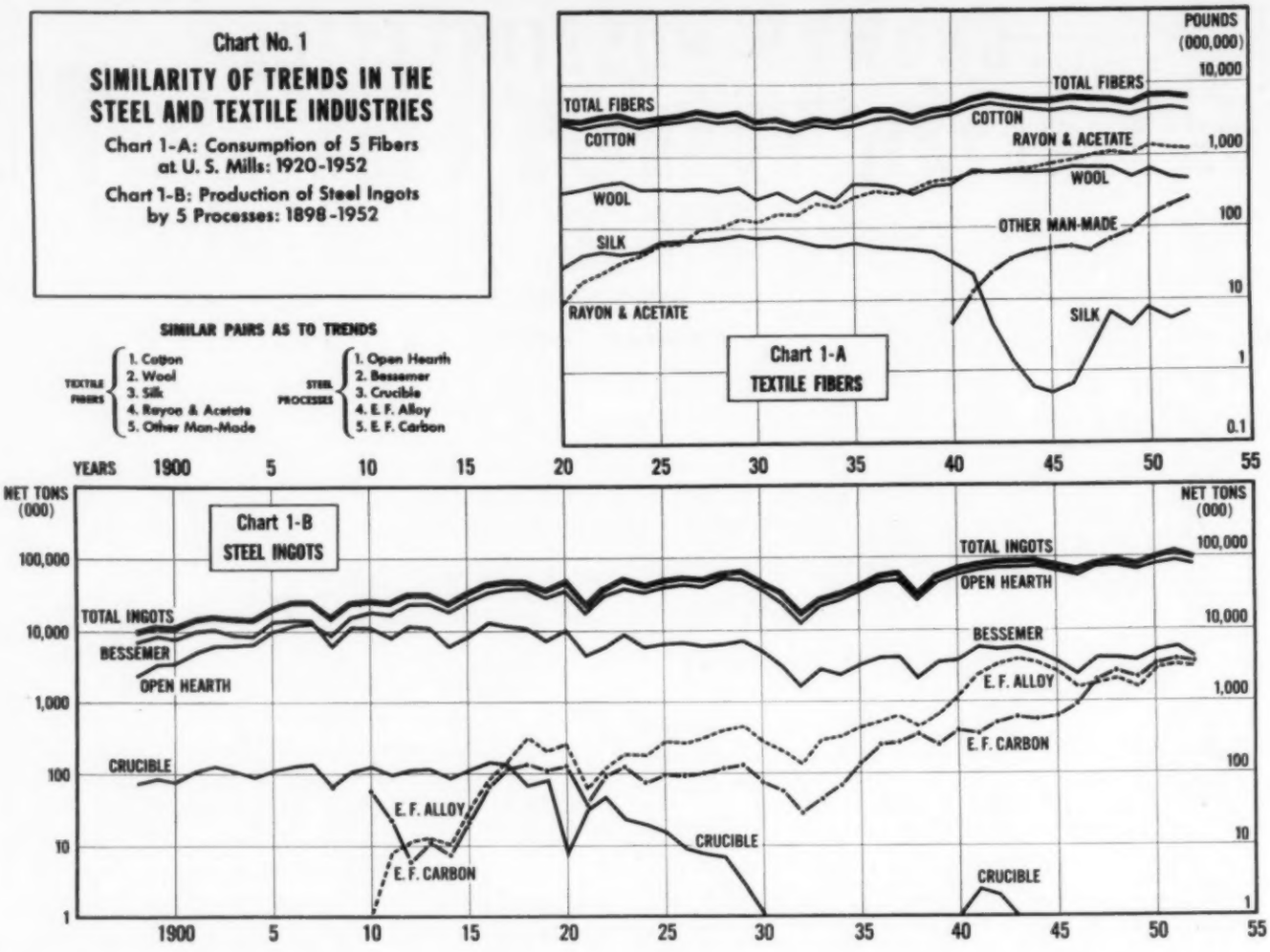
STEEL IS NOT UNIQUE

In the first place, it must be understood that what is happening in the steel industry is not unique. The textile industry affords a good example of a parallel. Chart No. 1 shows, at the top, the record of pounds of five different fibers consumed at United States mills from 1920 to 1952. At the bottom is shown the record of tons of steel ingots produced by five different processes from 1898 to 1952.

The striking thing about this chart is that the five fibres and the five steelmaking processes form five sets of pairs. Cotton and Open Hearth are each dominant and, in recent years, are losing percentage position compared with the totals. Wool and bessemer have each pursued a comparatively level course and have lost much of their strength to other fibres and processes. Silk and crucible have practically faded out of the picture. Rayon and acetate and electric furnace alloy steel have had long periods of dynamic growth and are currently near the levels of wool and bessemer, respectively. Finally, other man-made fibers and electric furnace carbon steel are staging the sharpest rises of all during the past ten years.

This remarkable similarity was noticed when the writer was preparing a report forecasting the long term potentials of fiber consumption in the textile industry and it is shown here because it demonstrates one important fact. *What is happening in the steel industry is part of a natural economic phenomenon and the principles used elsewhere in the economy to anticipate the future may be reliably used in the case of steel.*

The principles which are used here are highly specialized and not generally known. Therefore, they must be described before they are applied to the steel data. The method employed is the product of G. E. Conkling,



business consultant, of East Orange, N. J. It is based upon an analysis of what has actually happened in many cases of products and processes which have had successful records. It is the practical as distinguished from the theoretical or statistician's approach. This is illustrated in Chart No. 2.

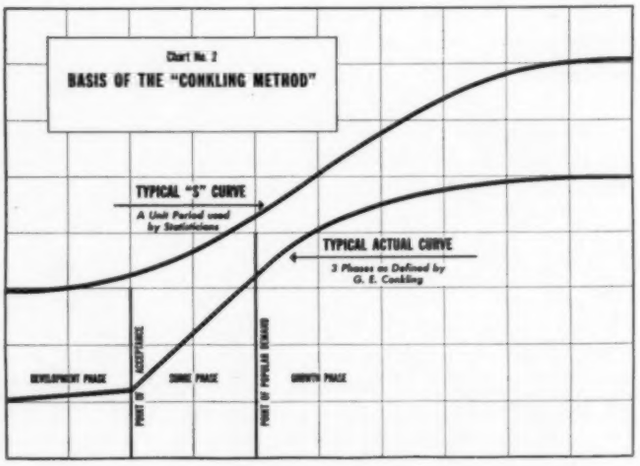
A PRACTICAL METHOD OF ANALYZING GROWTH TRENDS

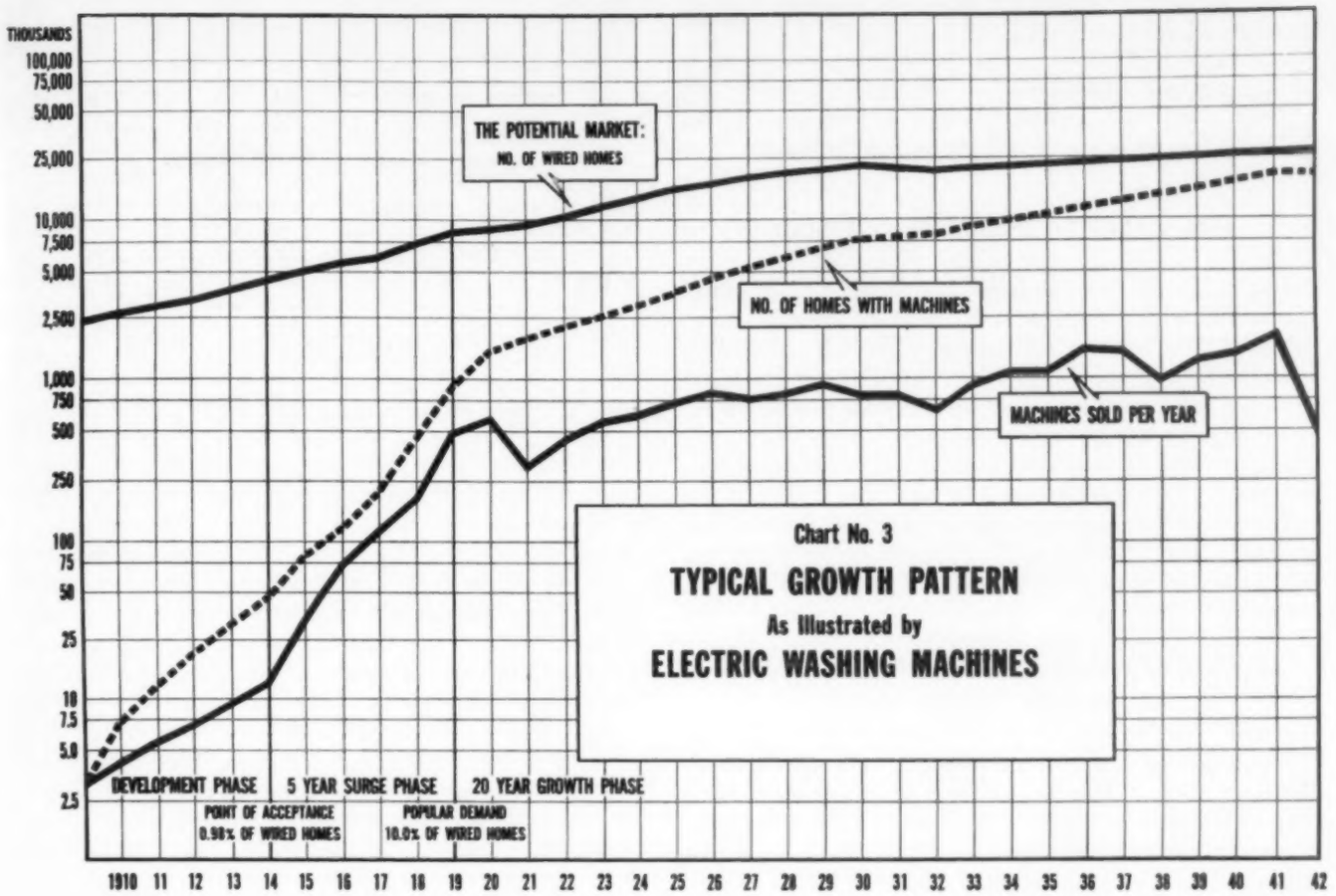
At the top of Chart No. 2 is shown a typical, theoretical sigmoid or "S" curve as used by statisticians who calculate an Einsteinian formula for its construction *as a unit*. Conkling observed, however, that in actuality the growth records of successes could not be understood when viewed as a unit. They were broken down into three distinct phases as shown by the lower curve.

First came a development phase of a few or many years. This phase ended when the product or process had reached a point of acceptance. Acceptance was earmarked by a number of characteristics such as satisfaction with use, widespread distribution, a period of prior sales stability and a following sharp upward break in sales of 30 to 50 per cent or more in one year. Perhaps the most startling feature of this point of acceptance was that it occurred at a very low point when only about 1 per cent of the potential market had been captured.

Second, a surge phase of five to six years was experienced when sales or use climbed at a rapid rate and reached a volume or percentage of potential which was from five to ten times that at the point of acceptance and which is identified here as the point of popular demand.

Third, a normal growth phase then ensued during which sales or use followed the general path of an "S" curve for the first time. It was noted that in cases where sales rose faster than average in the surge phase, they had a slower than average rate of increase in the growth phase and vice versa. In any event, the "S" curve led to an apparent resistance level in 15 to 25 years. These





resistance levels were usually within a bracket of 25 to 60 per cent of the potential market.

The application of these principles is illustrated by one typical case in Chart No. 3.

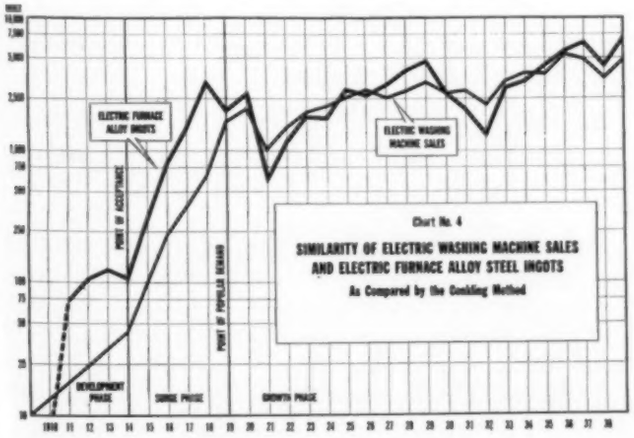
DEMONSTRATION OF THE METHOD

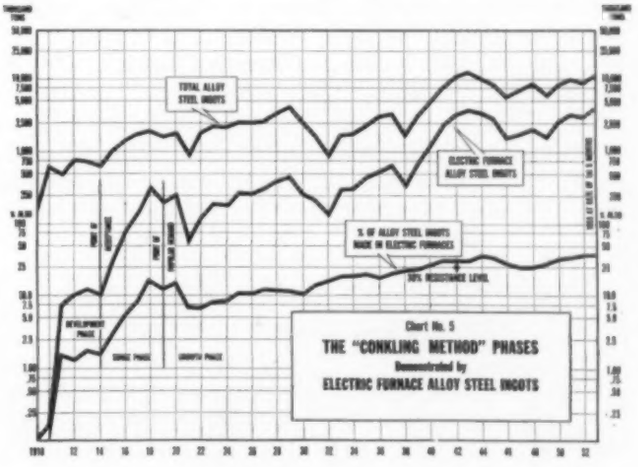
Electric washing machines were chosen as an example because there was available data to chart annual sales, accumulative number of homes with washing machines and the number of wired homes as a measure of the potential market. The chart covers the period of 1909 to 1942, sufficient for our purpose.

During the development phase of five years, sales were stable. The point of acceptance was reached in 1914 when the number of homes with washing machines was almost exactly 1 per cent of the total wired homes. In 1915, sales took the typical upward jump.

The surge phase continued for five years, including World War I, and ended in 1919 when the number of homes with washing machines reached about 10 per cent of the total wired homes. Having reached this point of popular demand, there could have been no doubt but that, given aggressive management, washing machine sales had a dependable growth phase ahead of them.

In the growth phase, the number of homes with washing machines grew along a typical "S" curve and reached a resistance level of about 35 to 40 per cent of total wired homes at the time of the depression. Two economic factors then supplied new acceleration and raised the resistance level. These were the N.R.A. raise


ELECTRIC FURNACE ALLOY INGOTS
ELECTRIC WASHING MACHINE SALES
POINT OF ACCEPTANCE
POINT OF POPULAR DEMAND
DEVELOPMENT PHASE
SURGE PHASE
GROWTH PHASE
Chart No. 4
SIMILARITY OF ELECTRIC WASHING MACHINE SALES AND ELECTRIC FURNACE ALLOY STEEL INGOTS
As Compared by the Conkling Method



in laundry prices and the drying up of available house servants at reasonable wages. As a result, a new "S" curve was superimposed upon the old one, leading to a 60 per cent resistance level.

Next it will be seen that there is a close parallel to this washing machine record in the steel industry.

A PARALLEL IN THE STEEL INDUSTRY

Chart No. 4 shows that the production of Electric furnace alloy steel ingots closely parallel sales of washing machines for exactly the same period of years, 1909 to 1939. Of course, World War I boosted steel higher than washing machines and the economic declines in 1921 and the thirties depressed steel more. Nevertheless, there can be no doubt that both enjoyed the same experience, especially when it is seen that electric furnace alloy steel ingots went through the successive phases of the Conklin method as shown here and as demonstrated even more clearly on Chart No. 5

ELECTRIC FURNACE ALLOY STEEL INGOTS FOLLOW THE TYPICAL PATH

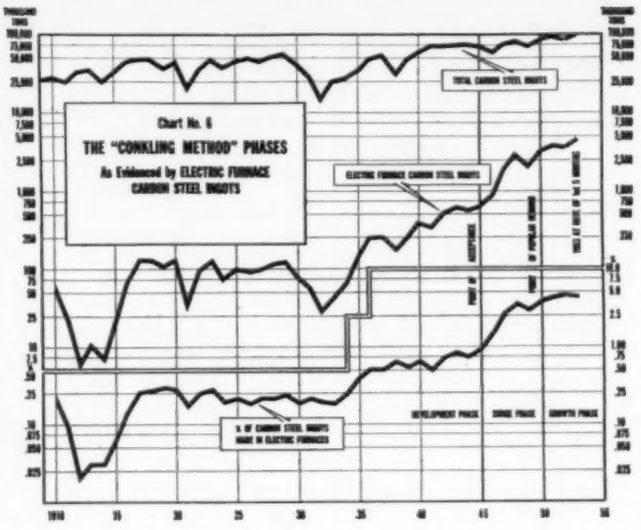
This chart compares the tonnages of electric furnace and total alloy steel ingots. In the development phase, there were four years of stable production of electric furnace alloy steel ingots at the 1.5 per cent level, ending in 1914. The surge phase carried up some eight times to about 12.5 per cent of total alloy steel ingots and almost 20 times the tonnage at the point of acceptance in 1914. The post-war recession in 1921 brought the electric furnace tonnage down to a normal of six times that of 1914 and 7 per cent of the total. In any event, the point of popular demand was reached in 1919 and the growth phase along an "S" curve persisted until a resistance level was reached in 1941 at about 30 per cent of total alloy steel ingots. This level, plus or minus about 5 per cent, has been maintained since.

This resistance level of 30 per cent is comparable with that of 35 to 40 per cent originally reached by washing machines. As in the case of washing machines, electric furnace alloy steel ingots may break through this 30 per cent level if some new technological or economic development of major force occurs. While others may be better informed, there is no such force visible to the writer at the moment, and in the projections, the 30 per cent resistance level is, therefore, assumed as having been established.

If the record of electric furnace carbon steel ingots be compared with that of alloy steel ingots, there is ample reason for concluding that the Conkling method may be applied to project their potential future growth.

ELECTRIC FURNACE CARBON STEEL INGOTS ARE ALSO GROWING TYPICALLY

Chart No. 6 compares the tonnages of electric furnace and total carbon steel ingots. It will be noted that the electric furnace tonnage held close to the very low



level of two-tenths of 1 per cent until business rose from the depression in 1934-1935. Then electric furnace tonnage clung near the ½ of 1 per cent level until World War II. All of this was part of a long development phase which did not end until the point of acceptance was reached in 1945, at the end of the war.

In that year, electric furnaces produced 0.89 per cent of total carbon steel ingots. The surge phase of the next five years carried electric furnace production sharply upward with typical immunity in 1945-1946 when all other processes were declining. By the time the 1949 sharp setback occurred, the surge phase was nearly completed and this immunity was lost.

In 1950 the point of popular demand was reached when electric furnaces produced 3.75 per cent or about five times the tonnage in 1945. This is very close to the typical bracket for a surge phase and the growth in subsequent years has been close to the typical rate of a growth phase.

Summing up at this point, it has been shown:

1. That there is a typical 3-phase pattern in the growth of many products and processes.
2. That washing machines followed this pattern.
3. That electric furnace alloy steel ingot production followed this pattern.
4. That electric furnace carbon steel ingot production has gone through the first two of these three phases.

The probability that electric furnace carbon steel ingots will follow the pattern in the third phase must be assumed or unmistakable grounds must be found for maintaining that a different and therefore exceptional experience will develop.

A POTENTIAL RESISTANCE LEVEL FOR ELECTRIC FURNACE CARBON STEEL INGOTS

Now it is possible to take another step toward the projection of a 25-year growth phase, from 1950 to 1975, by comparing the records of electric furnace alloy and carbon steel ingots in terms of their percentages of the total tonnages of their respective types. This is shown by Chart No. 7 to which have been transferred the bottom percentage lines of Charts No. 5 and No. 6.

In order to appraise the possible growth for 25 years ahead, it is helpful to measure 25 year rates of growth in the past. There are two methods of measuring past rates of growth in electric furnace alloy steel ingots over the 25-year periods. First a starting point may be taken in 1914 which was before World War I and at the end of a four year period of relative stability. Twenty-five years later, in 1939, the percentage of electric furnace alloy steel ingots had risen 14.2 times. This, however, was before the resistance level was reached.

Second, a more appropriate ending point may be taken in 1941 when the 30 per cent resistance level was first reached. This means starting with 1916 or the middle of World War I which provided an abnormal surge for alloy steel. To correct for this, the starting point in 1916 on the chart is set at 3.2 per cent which is the normal rise from 1914 by the Conkling method. Measured thus, the percentage of electric furnace alloy steel ingots rose only 9.3 times.

A measurement of the rate of increase in electric furnace carbon steel ingots which is comparable with the first measurement of alloy ingots is shown by the broken line joining 1924 and 1949 in the lower curve on the chart. The starting point is, as before, at the end of a four-year period of relative stability and the ending point is the conservative figure reached in the dip of 1949. Measured thus, the percentage of electric furnace carbon steel ingots rose 15.8 times or a greater amount than in the case of electric furnace alloy steel ingots by either measurement.

If, as is often done, this rate of increase be projected to 1975, it will end with electric furnace carbon steel ingots at 42 per cent of total carbon steel ingots. However, this would ignore the fact that the projection is being made from a point at the top of a surge phase and after a short period of unusually rapid growth. If the apparent 30 per cent resistance level of electric furnace alloy steel ingots is taken as the probable resistance level for electric furnace carbon steel ingots, it would need a rise of only 8.0 times to reach this level in 1975. This is conservative when compared with the second measurement of electric furnace alloy steel ingots which totalled 9.3 times.

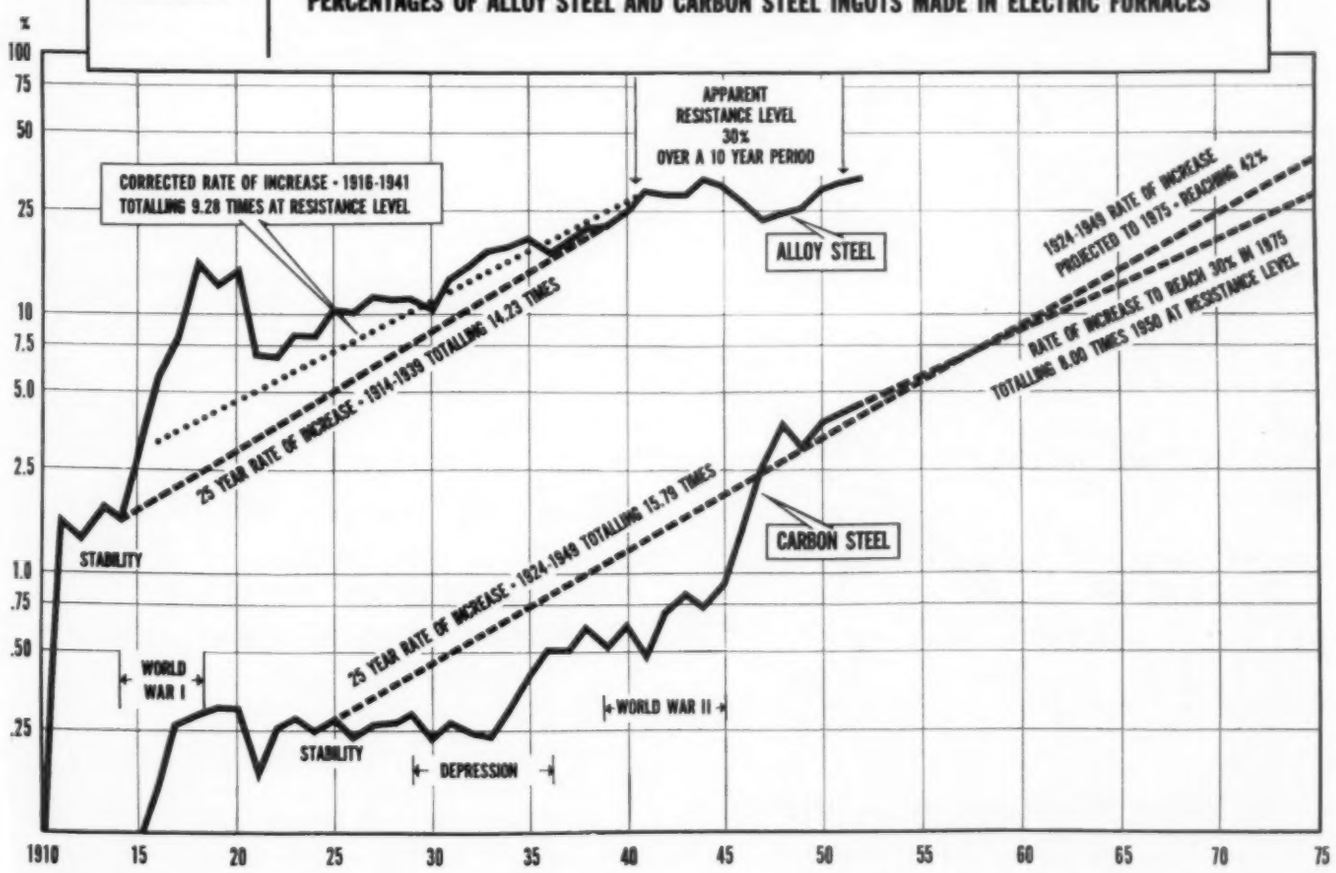
The assumed resistance level of 30 per cent for electric furnace carbon steel ingots recommends itself on these grounds:

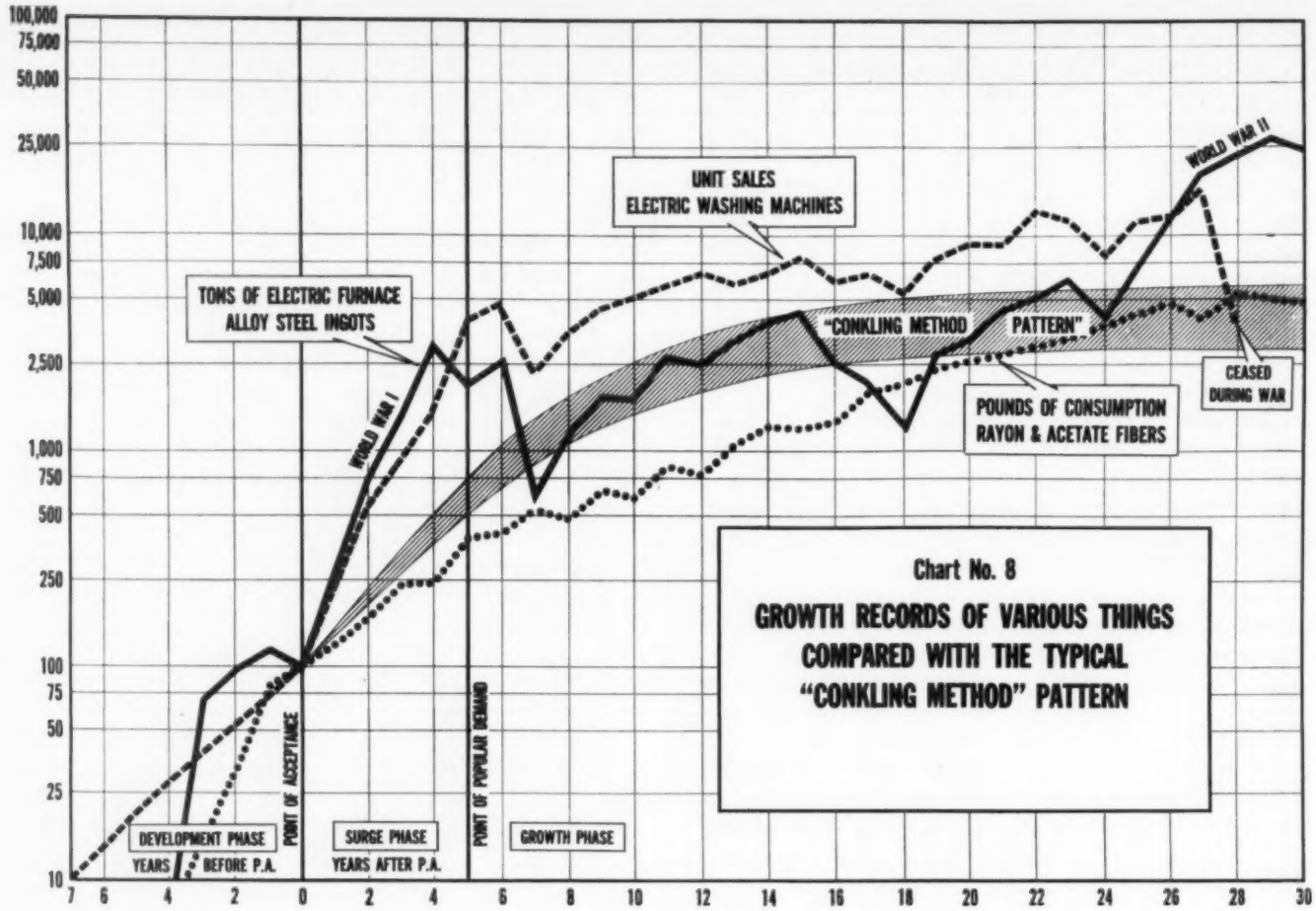
1. It is exactly the resistance level encountered in alloy steel ingots.
2. It is more conservative than the 42 per cent level based upon a continuance of the rate of increase in carbon steel ingots over the past 25 years.
3. The rate of increase to reach this 30 per cent resistance level is less than the lower of the two measurements of electric furnace alloy steel ingots.
4. It is near the bottom of the Conkling method typical bracket of resistance levels of other things as evidenced further by Charts No. 8 and No. 8A.

Chart No. 7

COMPARATIVE RATES OF INCREASE AND RESISTANCE LEVELS

PERCENTAGES OF ALLOY STEEL AND CARBON STEEL INGOTS MADE IN ELECTRIC FURNACES




100,000
75,000
50,000
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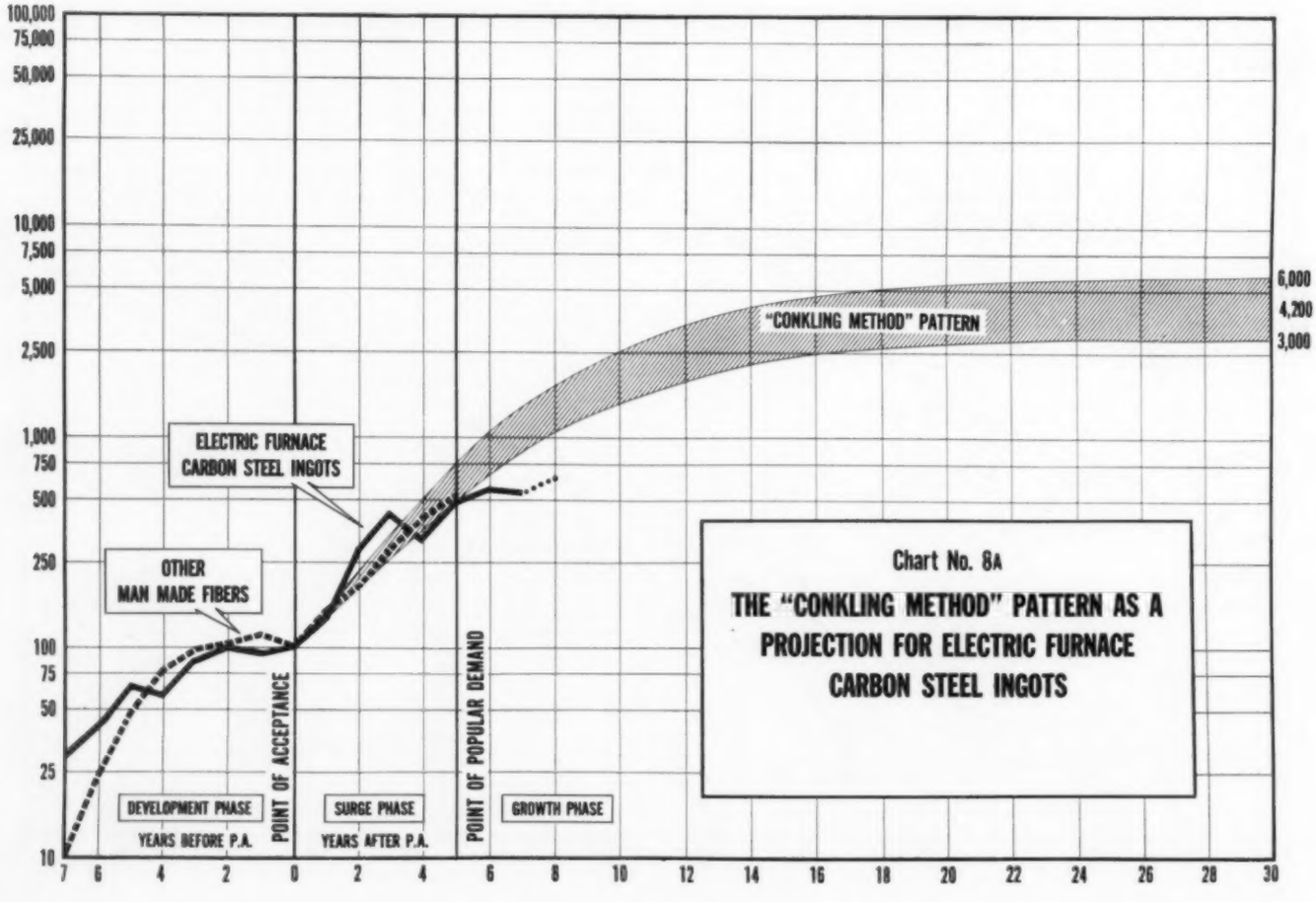
7,500
5,000
2,500
1,000
750
500
250
100
75
50
25
10
7 6 4 2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
UNIT SALES
ELECTRIC WASHING MACHINES
TONS OF ELECTRIC FURNACE
ALLOY STEEL INGOTS
"CONKLING METHOD" PATTERN
WORLD WAR I
WORLD WAR II
CEASED
DURING WAR
POUNDS OF CONSUMPTION
RAYON & ACETATE FIBERS
POINT OF ACCEPTANCE
POINT OF POPULAR DEMAND
DEVELOPMENT PHASE
YEARS BEFORE P.A.
SURGE PHASE
YEARS AFTER P.A.
GROWTH PHASE
Chart No. 8
GROWTH RECORDS OF VARIOUS THINGS
COMPARED WITH THE TYPICAL
"CONKLING METHOD" PATTERN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75,000
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750
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10
7 6 4 2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
6,000
4,200
3,000
"CONKLING METHOD" PATTERN
ELECTRIC FURNACE
CARBON STEEL INGOTS
OTHER
MAN MADE FIBERS
POINT OF ACCEPTANCE
POINT OF POPULAR DEMAND
DEVELOPMENT PHASE
YEARS BEFORE P.A.
SURGE PHASE
YEARS AFTER P.A.
GROWTH PHASE
Chart No. 8A
THE "CONKLING METHOD" PATTERN AS A
PROJECTION FOR ELECTRIC FURNACE
CARBON STEEL INGOTS

PRINCIPLES WHICH APPLY TO GROWTH PHASES

Chart No. 8 shows the records of three dissimilar things, all centered upon their points of acceptance and extending clear through their surge phases and growth phases to their resistance levels. These are electric washing machines, electric furnace alloy steel ingots and rayon and acetate fibres. The latter two were identified as a pair in Chart No. 1. The broad band is the typical Conkling method path.

Washing machine sales rose much faster than average during the surge phase, and consequently slower than average in the growth phase so that they end up very close to the average path. Electric furnace alloy steel ingots also rose faster than average in the surge phase but less rapidly than washing machines. Consequently they dropped down to the average path more quickly. Following the corollary to this principle, rayon and acetate fibres rose less than average during the surge phase and have been growing faster than average in the growth phase so that they are rising toward the average path.

These observations assist in appraising Chart No. 8A.

PRINCIPLES APPLIED TO ELECTRIC FURNACE CARBON STEEL INGOTS

Chart No. 8A shows the records of two other dissimilar things:—man-made fibres other than rayon and acetate (nylon, dacron, orlon, acrilan and dynel) and electric furnace carbon steel ingots. These were also a pair on Chart No. 1. Both have finished their surge phases and have begun their growth phases. Both have risen less than average. According to the principle demonstrated by Chart No. 8, their rates of increase in the growth phase may be expected to rise more rapidly than average and to come within the average path in 20 to 25 years just as have rayon and acetate fibres. This will carry other man-made fibres to about 20 per cent and electric furnace carbon steel ingots to about 30 per cent in 1975.

That is basically the contribution of the writer on this subject. There is one last step to be taken. This 30 per cent figure may be translated into terms of tonnage. To do this, the tonnage of total carbon steel ingots by all processes must be projected for 25 years. Study of the past record discloses a simple and acceptable means of doing this.

PROJECTED TONNAGE OF TOTAL AND ELECTRIC FURNACE CARBON STEEL INGOTS

It may not have been noticed but throughout this discussion, production and not capacity figures have been used. There is a good reason for this. Capacity figures are theoretical computations. However, production figures *at peaks* are practical, realistic measures of working capacity. On Chart No. 9, these practical

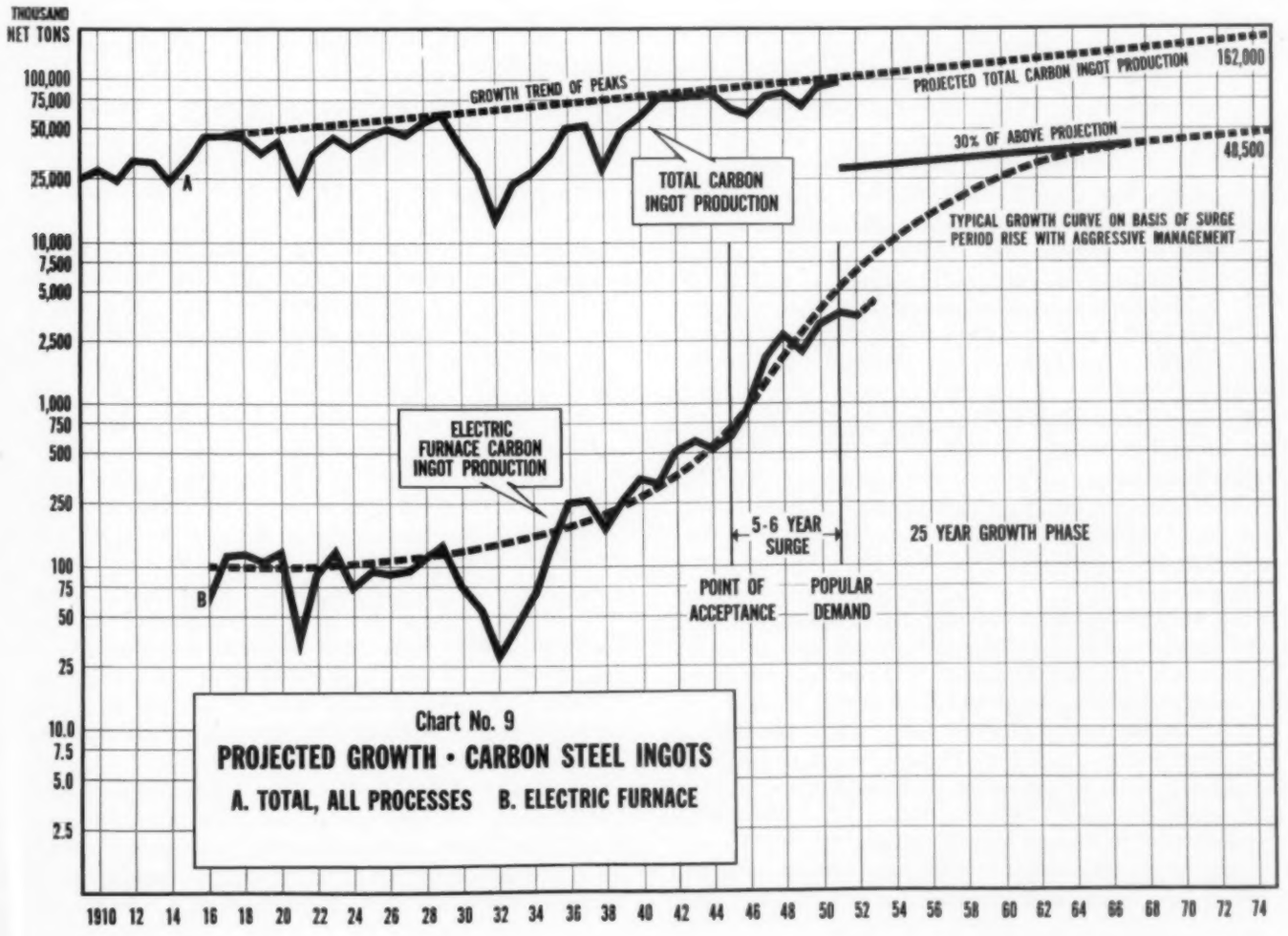

Chart No. 9

PROJECTED GROWTH • CARBON STEEL INGOTS

A. TOTAL, ALL PROCESSES B. ELECTRIC FURNACE

capacity peaks in production of carbon steel ingots in 1917, 1929, 1941, 1944 and 1951 are joined by a straight line. Since the chart is drawn on semi-logarithmic paper, this straight line shows a constant rate of increase over a period of 34 years.

Qualified economists say that the total economy is growing at an accelerating rate and that the current rate is 3.3 per cent a year. This means that, even with no further acceleration, the total economy will be 100 per cent greater in 1975 than in 1950. Think of that when prophets of doom say that the United States has reached a stage of maturity and lassitude!

The rate of increase in carbon steel ingots over the past 34 years, if projected to 1975, will mean a tonnage of about 162,000,000 or only 84 per cent greater than in 1950. This means that the estimates given here contemplate that steel production will grow at a lesser rate than the total economy. Thus some allowance is made automatically for any uses of steel which may be absorbed by other metals and materials.

Parallel to this top line which projects the tonnage of total carbon steel ingots is a line which represents 30 per cent of these figures, year by year. This is the assumed resistance level for electric furnace carbon steel ingots. The bottom curve shows the historic record of electric furnace carbon steel ingots and its projection through the growth phase on an "S" curve which reaches the 30 per cent level at 1975. The indicated tonnage in 1975 is 30 per cent of 162,000,000 tons or 48,500,000 tons.

It must be emphasized that the 162,000,000 ton figure is the maximum because it was arrived at by projecting the production peaks. It is obvious that this tonnage either of production or capacity will be reached only if general economic conditions similar to those which existed in past peak years also exist in 1975 or thereabouts. No one can give such assurance. If general conditions should be as they were in 1921, 1938, 1946 and 1949, the figure could be as much as 50 per cent lower as to production. This is why projections should always be thought of as being drawn with a paint brush and not a ruling pen.

Even if such adversity affected the whole economy, the tonnage of electric furnace carbon steel ingots would be about 25,000,000 tons or almost eight times what it was in 1950. So any figure between 25 and 48 million tons may be picked as the target for 1975. The average is about 37,000,000 tons. The writer would be inclined to settle for 40,000,000 tons plus or minus 4,000,000 tons.

DISCUSSION

PRESENTED BY

W. E. LEWIS, Vice President, Pittsburgh Lectromelt Furnace Corp., Pittsburgh, Pa.

E. E. BAUER, Manager, Transformer Apparatus Sales, Power Transformer Dept., General Electric Co., Pittsfield, Mass.

CHARLES VOKAC, Manager, Hydro-Arc Furnace Dept., Whiting Corp., Harvey, Ill.

WILLARD C. WHEELER, Management Consultant, New York, N. Y.

V. J. NOLAN, Manager, Industrial Sales Promotion and Development, National Carbon Div., Union Carbide and Carbon Corp., New York, N. Y.

W. E. Lewis: My first thought was to investigate the amount of increase in electric furnaces that would be made necessary by the tonnages projected. This involves, of course, setting up an estimate of the size and number of equipments needed to produce the plain carbon electric furnace steels indicated as the output for a time near 1975.

It would not be correct to figure on the anticipated electric furnace tonnage of that time being made on an all cold scrap melting practice. Even so, and allowing for the marked advance of the electric furnace into the field of operating with charges of scrap plus molten pig, the number of electric furnaces required probably would not be very appreciably reduced unless expansion should go in a direction where blown bessemer metal is used to a considerable extent.

Concerning 40,000,000 tons of electric furnace plain carbon steel ingots to be poured annually, one can assume as a start about 10 per cent of this production or 4,000,000 tons to be made at the present time in electric furnaces— these principally working on batch cold melt practice. It is customary in setting a yearly production figure for an electric furnace of say 20 ft-0-in. diameter and powered with 25,000 kva, to allow an operating factor of around 95 per cent. Accordingly, there are 680 hours in a month during which an equipment of this kind can tap around 20 tons per hour on batch cold melt practice. This is 13,600 tons per month or 163,200 tons melted per year. If we take the ingots made at 95 per cent of the tons melted, we have a furnace of this size giving us 150,000 tons annually.

Now with let us say 40,000,000 tons less ten per cent or thirty-six million tons to be made annually in furnaces having each 150,000 tons per year capacity, we have 240 furnaces needed. This means about eleven per year average over the twenty-two year period of 1953 to 1975.

As stated, this is only a rough way of forming a somewhat more tangible picture of equipment involved for the work signalled by Mr. Wheeler's charts. Naturally, if larger than 20 ft-0-in. diameter furnaces are used, the number of furnaces needed will be reduced to correspond. Also, if the molten pig and cold scrap rate of output exceeds that of cold melting, the need for electric furnaces will be less. At present, however, it is customary to take these outputs as not materially different. Further, if any considerable percentage of the electric furnaces in use are smaller than the 20 ft-0-in. inside diameter size that increases the number of installations needed.

No doubt of interest to many here is the approximate cost of the equipment being discussed. We can take a 20 ft-0-in. inside diameter furnace with 25,000 kva substation to cost, with charging buckets, about $600,000 installed (but not including allowances for

buildings, cranes, ladles, and items of that kind). Hence, the installation of eleven units of this size obviously would represent on the order of $7,000,000 worth of furnace equipment going in on the average yearly. This figure, as already discussed, would be modified by sizes of furnaces used and the type of practice employed.

Another aspect not yet touched upon in connection with cold melting is that large furnaces of the future probably will be higher powered than at present. Quite a few small furnaces are operated today with 1000 kva per ton of charge, whereas with a 20 ft-0-in. inside diameter furnace powered with 25,000 kva and running on 100-ton heats, we only have 250 kva in the substation per ton of charge.

Commenting further briefly on the higher powering of larger furnaces such as the 18 to even 30-ft diameter units it is plain this will involve such matters as:

1. Readiness of power companies to supply the power for doing the work.
2. The extent to which molten metal forms part of the charge.
3. Developments in electrodes, particularly from the standpoint of larger and more dense sizes.
4. Improvements in automatic controls.
5. Increases in furnace voltages.
6. Advances in secondary conductor designs.
7. Additional developments.

Looking at the setup of furnace units signalled for making plain carbon ingot steels over the next two to three decades, I believe it can be said that furnace manufacturers' shop facilities already exist for handling the building of these units at the average rate indicated. Consequently, unless some spectacular advance such as perhaps the cheapening of the cost of making power by utilizing atomic energy is found, and brings on a precipitous conversion from fuel-fired units to electric furnace production, the construction of this equipment using existing facilities should not prove difficult in any way.

Concerning taking the present production of common steels by the electric process as around 4,000,000 tons a year as is indicated in Chart 9, I have set down in a table rough estimates on the production this year of plain carbon electric steel ingots in the various shops in the United States. While the total tonnage arrived at is not represented as anywise completely accurate, still it may be interesting to mention on adding up the figures first compiled, it was found there was the equivalent of twenty-four 25,000 kva furnaces assumed to be doing the work. These furnaces are nearly 10 per cent of the units previously estimated as needed to reach the 40,000,000 ton productive capacity of Mr. Wheeler's charts.

Regarding the methods Mr. Wheeler sets forth for relating the growth of steel production to that of other products this was somewhat new to me and possibly has been, too, to most here. Most of us, I think, have been accustomed to add up heat cost, plus manhours, plus refractories, plus overheads, plus other production items for both the electric and the open hearth process, put these figures down as "cost above," and then add to these amounts the cost of the respective charges to arrive at a comparative cost per ton of metal in ingots. We have concluded from these summaries, as general rule, that the electric furnace is the preferable unit for batch cold melt work, but that the open hearth gains in its advantages as the size of the operation increases and as hot metal begins to form an increasing part of the charge.

While the time has not arrived to attempt to be too exact as to just how the electric furnace will advance in the field of using hot metal charges, one way in which this could evolve would be by using batteries of three furnaces in which a top charge cold melt furnace would supply molten steel to each of two hot metal furnaces. These two hot metal furnaces also would receive molten pig and/or where favorable to that, blown converter metal. The electric hot metal furnaces would be operated with as small electrodes as would carry the electric currents needed and the whole operation could be very nicely controlled as to power demand so as to do the work with the highest possible load factor and therefore minimize power cost. By this it is meant that the batch cold melt furnace would be on the fluidizing stage practically all the time, except when actually being charged and tapped, and the needed additional demand could be divided between the other two furnaces on a very accurately controlled basis with the provision that the input to each of the two hot metal furnaces could be increased at any time that the cold melting unit was off the fluidizing stage. Naturally, when either of the hot metal furnaces was being charged, tapped, or having its bottom fettled, there would be more power available for the other two units of the three furnace group.

Concluding these remarks, Mr. Wheeler, I feel, is to be congratulated on his work in putting before this Association a quite interesting and challenging study. Probably one of the most direct results of this paper will be to set many of us to work harder in devising ways to make the electric furnace even more rapid and economic. This timely material certainly will do much to promote the larger use of electric furnaces on molten pig and scrap charges.

E. E. Bauer: The writer would like to mention that his company has had the pleasure of working with Mr. Wheeler, and we are in a position to subscribe wholeheartedly to his projection of growth possibilities in the electric furnace steel business. We are interested in this growth for a number of reasons. First, we feel that we should anticipate the requirements of our customers and, in particular, to serve you people well. We furnish such items of equipment as transformers, switchgear and control, and unless these demands for such equipment are anticipated, we could even be a deterrent to this growth.

Secondly, we are interested in this projected growth because of the effect it will have on the utility systems of the country. Here, again, if the power supply requirements are not anticipated, it would be a severe handicap to both the utility industry and your industry.

It has been shown that the requirements for electric energy in this country have doubled approximately every ten years. In other words, the growth curve of kwhr consumption indicates that in ten years it will be twice today's consumption. Everyone wonders

where this additional consumption would come from, and, of course, items like this appear to contribute heavily to that growth.

One final conclusion should be suggested—namely, that if this growth is to take place, it should behoove someone to take an interest in the possibility of adopting as standard, certain components and perhaps circuit voltages that would be used for this application. This society has always been a champion of standards in the right places. This appears to be a very fertile field for the efforts of the proper committee.

Charles W. Vokac: I would like to comment upon Mr. Wheeler's development of the curves and the prospects of further development of electric furnaces. I was particularly interested in Mr. Wheeler's comment upon the shape of the curve being dependent upon the one important factor, technological developments.

A new furnace regulator has been developed, to promote technology in this field, which you will hear more about in the very near future. All indications show that this furnace regulator will further reduce costs of the electric furnace and further extend its competitive applications.

I would like to comment also upon standardization of equipment, mentioned just a moment before. At one of the sister engineering societies last year I had recommended, as a start, a certain set of standards for the arc-furnace transformer. I had hoped that this would develop enough interest and consideration to develop a standard, adding to it, subtracting from it, changing it as may be necessary to arrive at a universally acceptable standard for arc-furnace transformers, the largest and costliest single component in an electric furnace installation. Further economics would be realized by such a concerted effort that would further extend the application of the electric furnace and further help it to compete with other types of melting processes.

That was just about the sum and substance of the few points I had gathered while listening to the previous speaker.

Willard C. Wheeler: I am glad to have this opportunity to say one thing, which I customarily do say, and did not in this case, that is there is nothing predestined about any such projections as I have shown. These things only are presented as potential possibilities.

Top management in a great variety of industries, not only steel, but the power and other industries, have to make appropriate decisions if this is going to be an actuality. But I have never yet been willing to sell short the ability of the top management and technological brains of this country to reach goals of this kind. All past history prevents me from doing that.

V. J. Nolan: Mr. Wheeler has presented a very interesting paper and he is to be congratulated for the excellent way in which this material has been presented. We in the electrode business have been faced with the problem of supplying electrodes for this steadily increasing demand brought about by the growth of the electric furnace. We have been keeping records of the steady growth of the electric furnace for years, and have decided that the one feature above all that seems to appeal to the steel people is the flexibility of the electric furnace. Recognizing the steady growth, it was necessary for us to make preparations far in advance of electric furnace installations to build up furnace electrode capacity. In the past several years, we have spent many millions of dollars on new plants, new processes, new raw material sources, all pointing in the direction of improved quality of electrodes, solely for the purpose of being ready to cope with this demand.

Our electrode quality has more than kept pace with the increasing demands of the industry. The expanding interest on the part of the steel industry in this particular field is a challenge which we are in a position to meet, both from the standpoint of quality and supply.

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1954 AISE SPRING CONFERENCE

HOTEL BELLEVUE-STRATFORD

PHILADELPHIA, PA.

MAY 3, 4, 5

INSPECTION TRIP

FAIRLESS WORKS, U. S. STEEL CORP.

MAY 5

Developments in Communications

By W. M. MARTIN
Illinois Bell Telephone Co.
Chicago, Ill.

. . . . special communication systems of various types are being installed by all industry to aid in controlling production operations . . . .

▲ WE in the telephone business like to believe that we have had a part in the modern development of the iron and steel business. As your business has grown, becoming world-wide in scope, the need for and dependence upon communications has increased correspondingly. Meeting these communications needs has been and continues to be our number one job.

Just as your business has developed, special processes and equipment to meet the special needs of your customers, so has the telephone business developed and furnished special arrangements to meet special communications problems. This paper will high-spot a few of the communications developments, and will touch on one or two which are still in the future.

Seventy-seven years ago, the telephone was an inventor's novelty. Today there are over eighty million telephones in the world with over half of them in the United States. Many factors are responsible for this development but none is more important than research and engineering. A basic fundamental of the telephone business is that as the number of telephones increases, the problem of interconnection of each telephone with every other one increases disproportionately, and so does the equipment required to do the job. In spite of this fact, and an other reason for the continuing growth and development of the telephone system is that telephone service continues to become a better bargain. It is cheaper in terms of hours of work. For example, the skilled workman who, in 1940, had to work four hours to earn enough to pay his monthly bill can pay it, today, with earnings of about two hours' work. As a result, more and more people feel that they cannot afford to be without telephone service in the home, and the extent of use in business and industry is continually expanding.

The year 1912 does not seem too long ago to some of us. That was the year Lee De Forest brought his audion tube to the Bell System to be tested as a device to strengthen voice currents on long lines. Bell researchers took the audion and developed it into a high vacuum tube, which made possible transcontinental telephone service in 1915.

In the twenties came the development of radio, and by 1927 overseas telephone service had been successfully established on a commercial basis. The present method of providing overseas service, primarily by high frequency radio, has served excellently during the past twenty-five years. Now this method is rapidly being outgrown both in the amount of service demanded and in the quality of service. For the long look ahead, it is safe to say that new techniques will be developed, which will release this service from the limitations of the present transmission method.

Another use of radio has been in the expansion of telephone service to various kinds of mobile units. Today there is a wide use—police cars, taxis, trucks, buses and business vehicles of all kinds. The systems use VHF two-way radio or space radio as many call it. Many are private systems.

Two-way mobile radio communication systems are engineered and installed in a wide variety of arrangements to fit the particular communication requirements of our customers. The basic system consists of a radio base station, through which you may com-

municate with radio-equipped mobile units. The units can be in cars, trucks, engines, scooters, or anything that moves, including people using hand-carried radio equipment. The usual two-way mobile radio system is arranged to enable direct mobile-to-mobile communication without the necessity of always going through the base station.

I am sure that the mere mention of two-way radio immediately brings to your mind various ways it can be used in the steel industry to achieve more production with less cost and more safety. In the mill, instant two-way communications can be completed between personnel concerned with material and stock movements. Costly delays can be eliminated.

For example, recently in one of the area mills, the chief dispatcher of the railroad switching units which were equipped with mobile telephone service called to his switching engines saying that, "We need ten cars of a certain kind of ingot steel immediately. Do you have any in your string?" Within five minutes the ten cars had been located and set out for further processing. While this is not normal procedure, it is a striking illustration of the use of a mobile radio.

And there are many other uses—plant protection activities can be handled with more efficiency and speed —fire equipment and other emergency equipment can be dispatched immediately—close contact can be maintained between the control location and personnel at the scene of the emergency. In mining operations, expensive and heavy equipment can be operated with the maximum efficiency and safety.

The very nature of the radio spectrum and the confusion that would result if everyone was to be left to his own devices in the use of it has dictated the necessity to vest control in the Federal Communications Commission. The commission has the responsibility of allocating and regulating the use of the radio spectrum in the public interest, convenience, and necessity. In order to do this, they have established service categories and have assigned specific groups of frequencies to each category. Two-way mobile systems for the steel and other industries fall into the special and low power industrial services category. These two service classifications differ in that the special industrial service authorization covers the operation of a system providing a greater range of two-way mobile communications than can be provided with the low power industrial service. Low power industrial service is limited to the use of radio transmitters having input powers of three watts or less, and the radiating system or antenna must be within three feet of the associated transmitter. Under these qualifications, the low power industrial service is usually limited to the use of portable or so-called handi-talkie equipment.

Two-way mobile systems in both of these industrial categories are operated on frequencies assigned to the service in the 27-50, 152-155, and 455-458 megacycle frequency bands. Each of these frequency groups exhibit certain distinct operating characteristics. For example, under a given set of operating conditions, the lower frequencies, 27-50 megacycles, will usually provide somewhat greater two-way range than will the higher frequencies. However, in some cases, the lower frequency transmission advantage is offset by other considerations. Radio receiving equipments operating on the 27-50 megacycle frequencies are more susceptible to ambient man-made noise, which tends to degrade the quality of communications in areas of high electrical noise. Under certain atmosphere conditions, a transmission phenomenon known as "skip transmission" occurs. When these conditions prevail, stations hundreds of miles distant operating on the same frequency can be received at signal levels sufficiently strong to interfere with local communications. From the equipment standpoint, the antennas used for the 27-50 megacycle equipments are approximately six feet in length, as compared to about eighteen inches, for the 152-155 and five inches for 455-458 megacycle equipments. These considerations are not stated with the thought of building a case against the use of the lower frequencies. There are many service applications in which they are used with definite operating advantages accruing.

The 455-458 megacycle frequencies have not been used extensively because the radio equipments for these frequencies have just recently become available in production quantities. There appears to be every indication that the 455 megacycle frequencies will be used quite extensively for new industrial systems that will be installed, both for initial installations and to relieve traffic overload on existing systems.

There has been a definite tendency in the past several years to operate the two-way radio systems for interplant communications on the 152-155 megacycle frequencies. These frequencies are assigned on a shared basis, as is the case with all industrial frequencies. This has created some crowding on these frequencies, particularly around Chicago. The effects of this crowding can be minimized by engineering the systems for maximum compatibility and minimum interference. This can be done by limiting the radiations of each sending unit so that the coverage area does not needlessly interfere with distant stations.

The heavy usage of two-way radio, which has come to be an extremely important production tool, has caused the communication industry to develop improved equipments and improved methods of operation. Since there are, at the moment, no additional frequencies available for assigning, and there continues to be a heavy demand for industrial radio frequencies, one way to solve the frequency load problem is to obtain more use of the available frequencies. The problem is being solved in just that way. Equipments are available which will provide satisfactory operation on one-half the band width previously required. The immediate results—more channels and greater growth.

Since the beginning of radio as we know it, the Bell system has made extensive use of it and has pioneered in its development. In fact, we had one of the first broadcasting stations in the United States. We use two-way radio in many ways to provide overseas service, ship-to-shore service, general mobile service, emergency restoral service, and to provide toll and television facilities, and last but not least, private radio communications systems.

Not so well known but nevertheless of importance is our use of radio to provide telephone service off the beaten path.

The first use of radio for this purpose was to provide service to islands. More than thirty years ago radio was used to provide telephone service to the town of Avalon on Catalina Island, thirty miles off the California coast. Now, in addition to being used to serve islands, the systems employ radio on overland routes to serve out-of-the-way places.

Two years ago the Bellota Ranch in Arizona asked the Mountain States Telephone and Telegraph Company for telephone service. Bellota Ranch includes about ninety square miles of grazing land. It is located twenty-eight miles east of Tucson, Ariz. in the Santa Catalina Mountains. Thirteen miles of rugged mountains, almost impassable country, lie between the ranch and the nearest pole line of the Telephone Company. The construction of a telephone line through this country to the ranch would have been very expensive and the maintenance would be difficult.

The radio system installed was an adaption of the type used for mobile telephone service in urban areas. It operates on one of the channels in the 152-162 megacycle band. The F.C.C. wisely provides in its rules that these frequencies may be used secondarily for "rural" subscribers.

It is only natural then that we in the telephone company should follow through to capitalize on this knowledge in providing two-way mobile radio systems or private mobile systems, as we call them, to maintain our communication service as a complete service. The telephone engineers, install, and maintain the mobile radio system on a monthly lease basis to meet the special communications needs of our customers just as we provide our regular telephone service to meet their ordinary needs. The radio service includes everything that you are accustomed to receiving from us when you deal with us for your usual telephone requirements. When trouble occurs on your radio system, repair service is as close as your telephone.

In considering your communication requirements—whether to lease or to own—there are really only two principal factors that influence the decision as to the method to use—service and cost. We believe our cost to be reasonable and invite comparison. We believe our system service advantages are unequalled. The uniformly high quality of our service sets the standards of service in the communication field.

Some of the factors, we believe, that make our service excel are:

It is dependable. With this service, repairs are needed infrequently; but, when they are needed, they are made promptly so as to cause a minimum of inconvenience.

It is flexible. Additions, reductions, or rearrangements can be made on short notice to meet changing requirements.

In case of flood, fire, or other emergency, it is our practice to take special measures to restore service quickly. This has meant, in many past cases, replacing part or even all of the equipment without cost to the customer.

Improvements are constantly being made in the radio and telephone art, and with our service you get the advantage of these improvements. Our Laboratories have upward of nine thousand scientists, technicians, and others who devote full time to searching for new devices and techniques to make your telephone and radio service more useful and keep its cost low. At the present time, we are using radio equipment manufactured by four different manufacturers in addition to our own. We take the best that each company makes to supply you with the best radio service. If you have our service, as improvements are made, you will have the advantage of these improvements as they come along regardless of who makes them, and there will be no obsolescence costs to be concerned about.

It is a unified service; that is, each component of service that we provide is engineered to work properly with other parts of your telephone system. Our business is the furnishing of service rather than the sale of apparatus, and our revenues depend on furnishing continuously satisfactory service.

Radio and its ramifications are very interesting discussion topics and, once started, it is difficult to stop. Those of us working with it feel that there are many developments yet to come.

Another newly developed service that we are in a position to offer on an experimental leased service basis is closed circuit video or industrial television. This new development is expected to have widespread industrial applications.

The basic closed circuit video system consists of a video camera, which is interconnected through special cable facilities to a video receiver or receivers. It makes possible the observing of industrial processes which could not be seen through any other practical means, or it provides a way of obtaining central observation of industrial processes. Closed circuit video systems have been successfully used to monitor the amount and composition of smoke issuing from the smoke stack of a power house, to monitor water level glasses on large boilers, to monitor remote meters at a central point, to monitor distribution and loading of steel scrap in gondolas which cannot be seen by the person manipulating the loading machinery.

One of the most graphic illustrations of usage that I have seen concerns the application of video to strip mining operations. As you know, the shovels used in this mining operation are extremely large, and for maximum efficiency the scoop should be filled to maximum capacity on each pass. This always presents a problem due to the fact that the shovel operator cannot see the scoop loader. A video camera was mounted on top of the shovel's boom, focused on the scoop at loading position; results in maximum load on each pass with reported large economies.

An entirely different use is shown by a service inquiry to provide closed circuit video to monitor an employee training conference so that the effectiveness of the material presented and the reaction to it could be determined by persons not directly participating in the proceedings.

The iron and steel industry undoubtedly can visualize many possible applications. We are currently in the process of completing our first black and white installation for a steel company in this area which will be used to detect and eliminate a possible malfunction in a rolling mill operation.

There have been many other improvements and developments to meet the needs of industry. Take elec-

tronic paging systems; they are not new, but with the growth of business and industry, improvements in the application of the systems have been made. For instance, we are working with a steel mill to engineer a paging system to cover the entire mill. It is estimated that about 200 speakers will be required. We are planning the system so that the speakers in one building may be used to page or call an individual without sending the message out over the entire network. At the same time, if you wanted to find a maintenance man who might be anywhere in the plant, the entire system can be used simultaneously to locate the individual.

We also furnish paging service which is directly connected to our dial telephones associated with our dial switchboard service. Any dial telephone may be used, as the sending station on the paging system by dialing a code and making the announcement over the system. We also furnish two-way paging service for small installations so that when the individual being paged hears his name being called, he can walk to the nearest speaker and by throwing a key mounted at a convenient height, he may talk in to the speaker and his voice is carried back to the originator.

Another improvement eliminates the need for a separate buzzer block for signaling in connection with an intercommunicating system within an office or plant. Most engineers are familiar with the present system. For example, an incoming call is received and perhaps you need some information from someone in the office. You operate your hold key to hold the calling party, press the intercommunicating key on your telephone instrument, and then reach over to the buzzer to signal the person in your office to pick up the intercommunicating line. While this is not difficult with one push button, it becomes a problem to find the right push button when you have seven or eight push buttons. Under the new system, instead of pushing the push button, you merely dial a designated digit on your telephone for each person you want—say "2" for example, and this signals the proper person. Thus, the buzzer block is eliminated.

A trial to determine the usefulness of another development is under way. This is a telephone dictation recording service for use in a factory or office so that an occasional user can dictate his letter or reports. Since the equipment is available 24 hours a day, the night supervisory force is making extensive use of the equipment in this test. The extension user dials designated digits to start the recording machine, suspend dictation, make corrections, have the machine play back or bring in an attendant. When his dictation is concluded, he dials another designated digit to so indicate. The dictation is later typewritten by a typist and then delivered.

Another new development is the management communicator system, which is now being used in several large plants in Illinois. This is a system which is used by them to keep their management people informed about current company news. It beats the "grapevine" in both speed and accuracy. An extension user dials a telephone number which is answered by the communicator equipment that plays a recorded message. The recorded message may be changed at any time.

Still another new development is automatic telephone answering service during periods when the telephone cannot be answered in person. The calling party hears a recorded message, and if he wants to leave a message, the equipment tells him how to do so.

A rather unique use of this service is being made by one of our customers. This company has had some union grievances where employees claimed they had reported their absence but the company had no record of the call. It was mutually agreed between the company and the union that a separate telephone line equipped with an automatic answering device be installed. In this way a permanent record of the employee's call is obtained.

Microwave is generally considered as that use of radio for communication purposes in the frequency range above 900 megacycles. Above 900 megacycles, the frequency spectrum is sufficiently great that you can utilize radio or microwave systems which use relatively large bandwidths. When you have a large bandwidth, 60 to 120 megacycles, you can begin to think of systems with large circuit handling capabilities. There is further advantage to microwave that the propagated energy behaves much the same as light rays and, accordingly, you can focus them into very narrow beams and obtain a degree of privacy. For that reason, microwave has made possible the utilization of radio to provide communication channels on a favorable, economical basis as compared to wire circuits. At lower frequencies, the limited bandwidths available makes the use of radio generally uneconomical as compared to wire facilities. The net result is that today you hear of ever-increasing use of this facility. The Bell System, for example, has installed the longest and most complex system in the world from New York to California, our TD2 System, to provide large numbers of telephone channels, 1800 two-way channels on one system, or two one-way video channels for the broadcast television industry. There is every indication that microwave will play an ever-increasing part in the communication picture of the nation and world.

Now that such a glowing picture of this new communication medium has been painted, the thought occurs, "How can we use it?" That, truthfully, raises a problem. At the present time the ground rules of the Federal Communications Commission permit certain specific groups within the industrial category, such as power utilities, railroads, and the petroleum industry groups to qualify for microwave frequencies. As a matter of interest, we are installing a 24-channel capacity microwave system for a power company between several of their facilities. This is a leased service. The regular industrial user in the manufacturing classification does not qualify for microwave facilities if the required facilities can be provided by conventional wire means.

Communications is our business and the most fascinating thing about the telephone business is that new opportunities for service are continually occurring. The well-tested teamwork of the operating, research and development, and manufacturing branches of the Bell System will continue to bring about continuous and rapid progress in the art. And our understanding of what the customer wants or needs must fully match our technical ability to find ways of filling those requirements. If we can be of help to you, that is our job.

ELECTRICAL SYSTEMS FOR HOT STRIP MILLS

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. . . . design refinements are increasing speed and productivity of hot strip mills . . . .

▲ IN the year 1500 Leonardo da Vinci designed a 4-high sheet rolling mill. It was intended to elongate a sheet which was about one-half a meter wide. Four hundred and twenty-six years later, only twenty-seven years ago, the first continuous hot strip mill using 4-high rolls was placed in operation. Initial production was around 12,000 tons per month. Today there is a record of production on a single mill more than twenty times greater.

During this relatively short growing period there have been many refinements in operations — each one contributing in some measure to producing better steel faster — and more economically. An improvement in quality, width or gage, an increase in quantity, or a decrease in losses of all kinds by even minute percentages of total production are extremely important considerations. All of these considerations are becoming more closely associated with the electric drive systems. Without good reliable electric systems of drive and control the present-day requirements of a hot strip mill cannot be met.

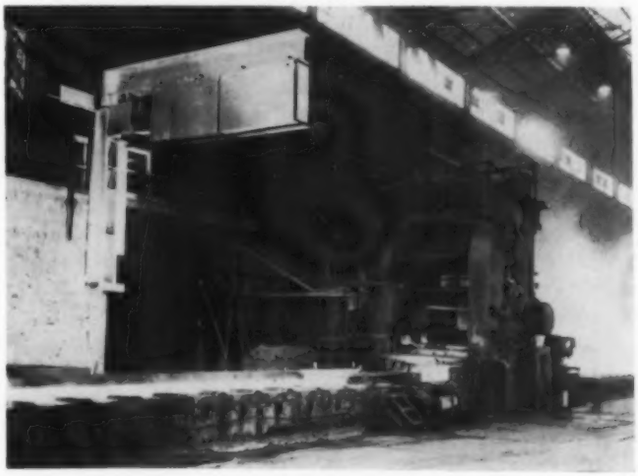
It is not the purpose of this paper to review all the electric systems that have been conceived during these past twenty-seven years of development. Rather the purpose is to further study the systems in use or available today, and to review the contributions which the manufacturer of electric equipment can make to hot strip mill operations.

WIDTH GAGE

One of the most recent additions to the mill operator's tool chest is the width gage. This device gives immediate and continuous indication of metal width at some preselected location in the rolling train. Figure 1 shows the installation of such a gage directly after a roughing mill. Figure 2 shows the essential components of the gage.

This width gage consists of an electronic detector head mounted fifteen feet above the hot strip so as to be away from scale, severe heat, corrosive fumes and cobbles. In this head there are two detector units mounted on an adjustable lead screw so that they can be positioned over each edge of the strip. Light from each edge of the strip is focused on separate photo tubes. The focused beam of light passes through slots in a rotating disc. There is one rotating disc and one photo tube in each detector unit. The slots sweep across the image of the strip edge at right angles to the direction of strip. The image of the strip on the photo tube is much like that which would be impressed on the film of a camera with a focal plane shutter — operating about thirty times per second.

Figure 1 — A width gage is shown located on the delivery side of the roughing mill.



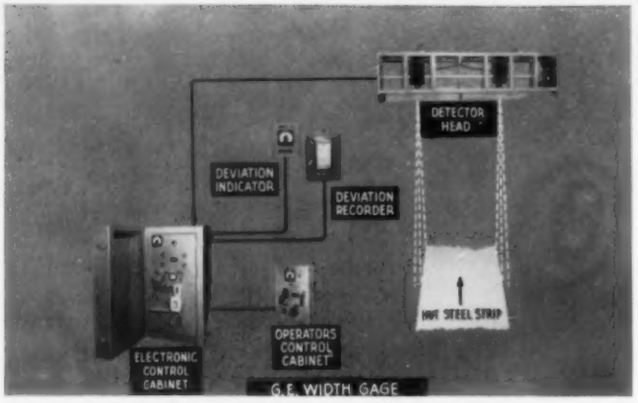


Figure 2 — Essential components of a width gage are shown in this illustration.

The light signals cause each detector to produce a pulsating square wave direct current. The length of each pulse is proportional to the distance from the inner end of the sweep to the edge of steel. The square waves of each detector are amplified and added together, and compared with a direct current to produce a current proportional to width deviation. If the strip shifts sidewise, one signal becomes longer as the other becomes shorter. The sum of the two remains constant. Sidewise movement has little effect on accuracy. The movement must, however, be confined to plus or minus three inches from normal. Vertical motion of the strip has little effect because the detector is vertically above each edge of the strip. Since light from the strip is used only to start and cut off each pulse, the usual variations in temperature of steel have little effect on operation. The adjustable range of operation is from 10 to 96 in. in $\frac{1}{8}$-in. increments. The accuracy of indication is plus or minus $\frac{1}{8}$-in. or better.

Other such gages are being built for use at the end of the finishing mills. This location means more time elapses before corrective adjustments can be made on roughing mill edgers. However, it does provide a means to determine the amount of necking down or stretching resulting from the use of tension between stands.

X-RAY GAGE

Another most valuable tool now in common use is the x-ray thickness gage. This gage has been described in previous papers presented at AISE meetings. The value of this device can best be appreciated by a study of a typical record chart — as shown in Figure 3. The thickness of the back end of the strip tends to be greater than the front end. We know that the back end remains in the mill longer and therefore cools more. This cooling contributes to an increase in gage. It is interesting to note the four definite heavy gage points on each strip. These are attributed to lower temperature spots where the slab comes in contact with the water-cooled furnace rails. The recorder connections are arranged so that between strips it runs at reduced speed and follows a pre-selected line near the actual thickness to be recorded.

Some quite promising improvements in gage have been obtained by the use of taper sprays to equalize strip cooling. We also know that the variation in gage may be less if the temperature of slabs can be maintained at maximum limits.

It is common practice to correct gage by adjusting the screws of the last finishing stand. This may require simultaneous adjustment of motor speed to avoid excessive looping or stretching between stands. The practice may become quite involved when the time allowed for resetting is limited by the next oncoming strip.

If the speeds of all finishing stands are held constant, and both the entering gage and temperature of metal are uniform, we should expect the delivered gage to be uniform. When the temperature of the metal cannot be controlled within desirable limits, we can resort to compensating changes in roll pressure on the roughing mills or on the first finishing stand. Compensation for variations in gage can be made in a similar manner. Corrective adjustments of the roll pressure (and speed if necessary) on either the roughing mills or the first finishing mill are preferred, because they do not necessarily require corresponding changes in either speed or roll pressure of the other finishing stands.

The adjustment of either the roughing mill or finishing mill screws could be made to function automatically from an X-ray gage or even some adjustable time signal if desired. There are, however, many problems associated with position control of screws. Not the least of these is to get the screws reset to the original position before the next strip arrives.

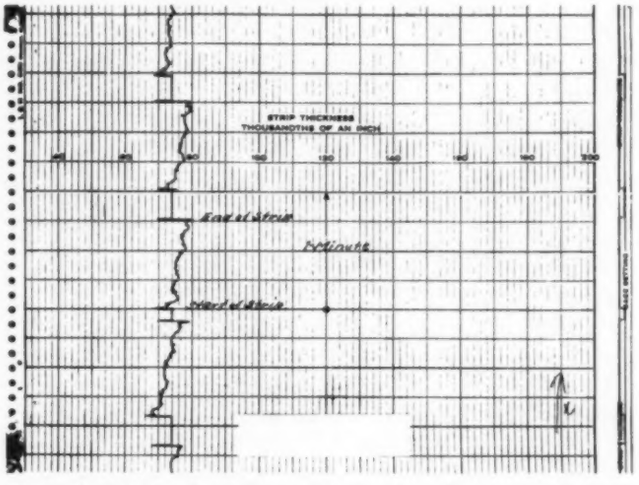


Figure 3 — This chart from a hot strip mill was made with a 100-kv X-ray thickness gage.

We know that on some cold strip mills gage is affected by the speed of rolling. It is not improbable that hot mill gage could also be improved by gradual increase of finishing mill speeds as the strip progresses through the mills. Electrically, this is an easy thing to do. The regulating systems to be described herein can be arranged to incorporate such a feature.

Our mill builders and operators need first to determine where the correction should be made, what magnitude of motion and torques are required. You can be sure the electrical manufacturer will provide equipment to meet requirements when they are made known.

COMMON BUS VOLTAGE REGULATION

The above approaches to the gage problem are dependent on how accurately the driving motor speeds

can be controlled. The majority of continuous hot strip mills have the finishing train motors supplied from a 600 or 750-volt bus common to all motors. Variations in bus voltage are reflected directly into motor speed variations. We should therefore first consider means to maintain constant bus voltage.

Figure 4 shows the essential details of a common bus voltage regulating scheme. Dial "A" of the motor-operated master rheostat adjusts the field of a generator field exciter GE to obtain the desired generator voltage.

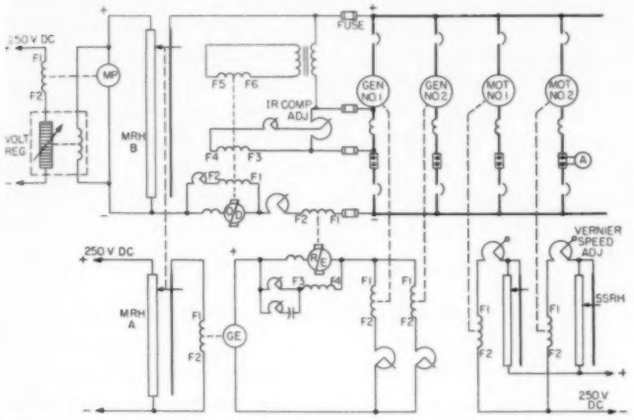


Figure 4 — Scheme shown is used for voltage regulation with a common bus system.

The resultant generator voltage is then compared with a reference voltage provided by a pilot exciter MP through dial "B" on the master rheostat. If the comparison senses an error in voltage, current will flow through a control field F1-F2 of the regulating exciter RE. This exciter will in turn readjust the generator field in a direction to cause the generator voltage to more exactly match the selected pilot reference voltage.

Unavoidable circuit resistance causes a droop in the

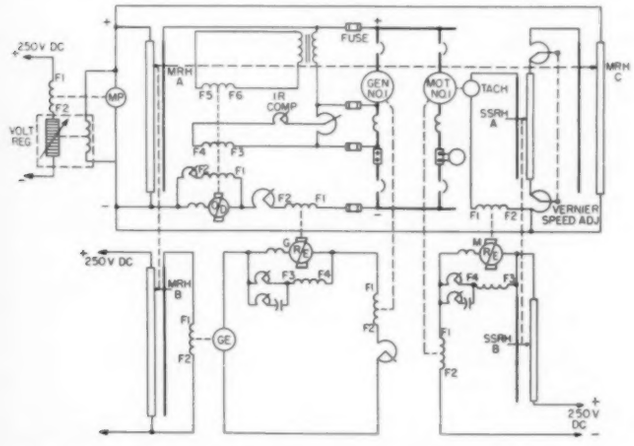


Figure 5 — Sketch shows a common bus voltage regulator with individual motor speed regulators.

internal voltage of a motor when load is applied. This voltage droop may result in a corresponding droop in motor speed. If the load imposed on all motors resulted in the same speed droop on each motor, it would be possible to readjust the generator voltage proportional to load and in the proper direction to compensate for the droop and thereby maintain essentially constant speed.

On a common bus system this compensation can be obtained by the use of an OD machine shown in Figure 5. The voltage of OD machine which is proportional to generator load adds to the voltage of the master pilot reference causing the generator bus voltage to be readjusted to the proper level. This feature is advantageous where the average motor speed droop can be represented by the generator load signal.

The use of the OD machine also provides a means to obtain the stability adjustment necessary for a high gain and high speed of response voltage regulator.

The master pilot is here provided with a separate voltage regulator. The pilot voltage is balanced against a spring in the regulator. Therefore any tendency to drift due to heating or variation in excitation supply is eliminated. This device is justified where very accurate bus voltage regulation is desired. The bus voltage can be no better than the reference to which it is regulated.

The individual stand motor speed, with this scheme, is adjusted by a motor-operated field rheostat and its associated manually operated vernier.

MOTOR FIELD REGULATORS

Even though motor armature voltage is held constant, motor speed variation may occur as a result of changes in load, excitation voltage, machine heating, etc. Attempts have been made to improve the speed regulation of stand motors by the use of series exciters. These are small exciters so connected that they develop a voltage proportional to line current. The voltage is used to excite an auxiliary shunt field on each motor in such a direction to partially correct for the speed variation. Unfortunately the response time of these exciters is slow and they cannot be made to give a voltage characteristic suitable for all load conditions at various operating speeds.

Manual adjustment of motor fields is sometimes made through an auxiliary exciter. This proves advantageous where motor field currents can be adjusted more satisfactorily through smaller devices in the exciter fields.

Studies have been made in the use of motor field current regulators such as those in use on tandem cold mill equipments. Such regulators are intended to maintain preselected values of field current. They have the advantage of not only being able to adjust the field currents through small control devices but also the time to change from one speed setting to another is greatly reduced.

The electrical components required for such motor field control are also suitable for motor speed regulators. Analogue computer studies have been made on hot strip mill speed regulators. These studies indicate that when small changes in speed are required — such as those a pulpit operator would make in his vernier controls — they can be made by motor field change just as conveniently as by generator voltage.

Figure 5 shows such a speed regulating scheme. The bus voltage is regulated as in the previous scheme, Figure 4. The motor field excitation is first adjusted by speed selection rheostat SSRH dial "B." Then the setting of dial "A" on SSRH and dial "C" of the master rheostat MRH determine what the tachometer voltage should be. Any error between the tachometer voltage

and the pre-selected reference voltage causes the motor field regulating MRE to adjust the motor field excitation to the correct value.

This scheme has been proposed for use on an existing common bus installation where accurate speed regulation is desired.

INDIVIDUAL STAND GENERATOR

There is now one hot strip mill in operation which has an individual generator for each finishing stand motor. The control scheme used for this installation is shown in Figure 6. All generator voltages are compared to a common reference pilot voltage. The pilot voltage in this case was not regulated, but adjusted through the master rheostat. The operator's vernier speed adjustment is obtained by line voltage control through the regulating machines. It will be noted that the speed selecting rheostat SSRH is provided with an extended voltage control dial "B." This permits the motor to be operated below base speed on reduced armature voltage.

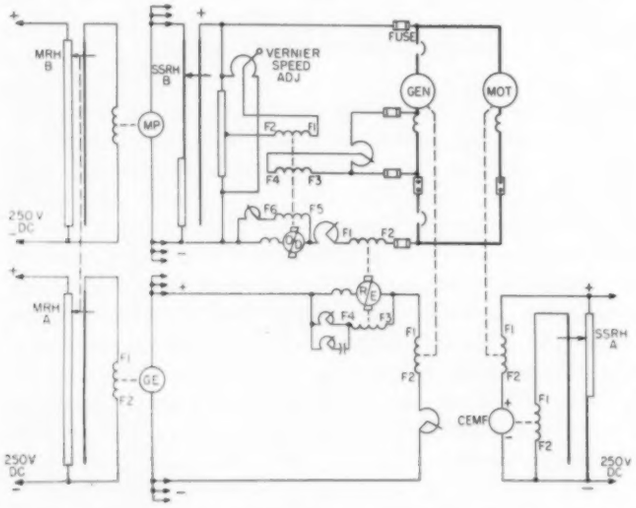


Figure 6 — Scheme shows voltage control for drives with individual regulators.

The per cent range incorporated in the operator's vernier speed control is held constant by virtue of the connection across the line reference voltage. This connection could be made across the pilot if greater range is required on reduced voltage operation.

This scheme makes possible the use of motor IR compensation to more nearly approach the performance of a speed regulated system. Figure 6 shows this feature connected in through field F3-F4 of rotating regulator OD. Actually, the system then becomes the same as that used so successfully on individual generator tandem cold reduction mills.

Individual generators provide the greatest flexibility in motor speed adjustments because the armature voltage as well as the field of one motor can be adjusted independently of the others. The overall generating capacity may not necessarily be any greater. There are some common bus systems in use where the generating capacity is about equal to the connected motor load and the trend is definitely in this direction. Fault currents with individual generators are less. Many common bus systems in use today would theoretically fall apart in the event of a solid bus fault. Fortunately such faults are made less likely by wide spacing of the positive and negative buses. The location of circuit breakers reasonably close to the machine armatures provides additional protection against damage to the machines in the event of a fault.

ELECTRONIC REGULATORS

In the system so far described rotating regulators are used. Many regulating systems have been conceived using electronic devices. These compared with the rotating type of regulators are faster in response, capable of greater sensitivity and perhaps less expensive. They have not, however, proved to be fully reliable nor free from faulty operation on large capacity installations. For these reasons they are not usually considered on hot strip mill applications.

MAGNETIC AMPLIFIER

The magnetic amplifier is a static device now receiving very favorable consideration on practically every electric regulating system. It consists essentially of a saturable core reactor resembling a transformer with one or more laminated cores designed for operation at magnetic saturation. A typical circuit is shown in Figure 7. The iron core when saturated permits current to flow from the a-c source through the load resistance. An input signal to the control winding around the laminated cores initiates this magnetization. The load current is rectified so that the d-c component of it further magnetizes the core in greater magnitude. Load current is, however, permitted to pass in only one direction. When "buck and boost" feature is desired, we must either use two units or bias one against some reference voltage. Here a word of caution is appropriate. When the a-c supply to a magnetic amplifier is interrupted, the controlled output goes to zero instantly. This may on some systems cause an objectionable disturbance on the power bus — even machine flashovers — if more than just a vernier range is entrusted to the magnetic amplifier. The loss of a-c power on a

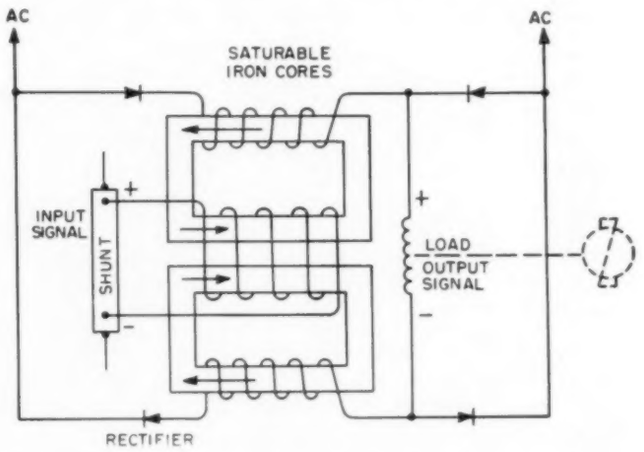


Figure 7 — Simplified diagram shows operation of magnetic amplifier.

rotating regulator eventually results in loss of control, but some time does elapse before rotation stops. This time is of value in reducing transient disturbance.

Suppose for example a magnetic amplifier were used to control or even supply all the generator excitation load. A sudden collapse of amplifier excitation means that the generator voltage will decay at a rate directly proportional to the generator field circuit time constant. This may cause pumpback currents of flashover magnitude.

MERCURY ARC RECTIFIER EQUIPMENTS

Parallel operation of rectifiers and generators on a common bus system presents no special electrical problems. This has been done several times and is frequently given consideration where existing generating capacity is inadequate. The generators on these installations are used to start the mill and the rectifiers are automatically connected to the bus after the voltage has reached some pre-determined level.

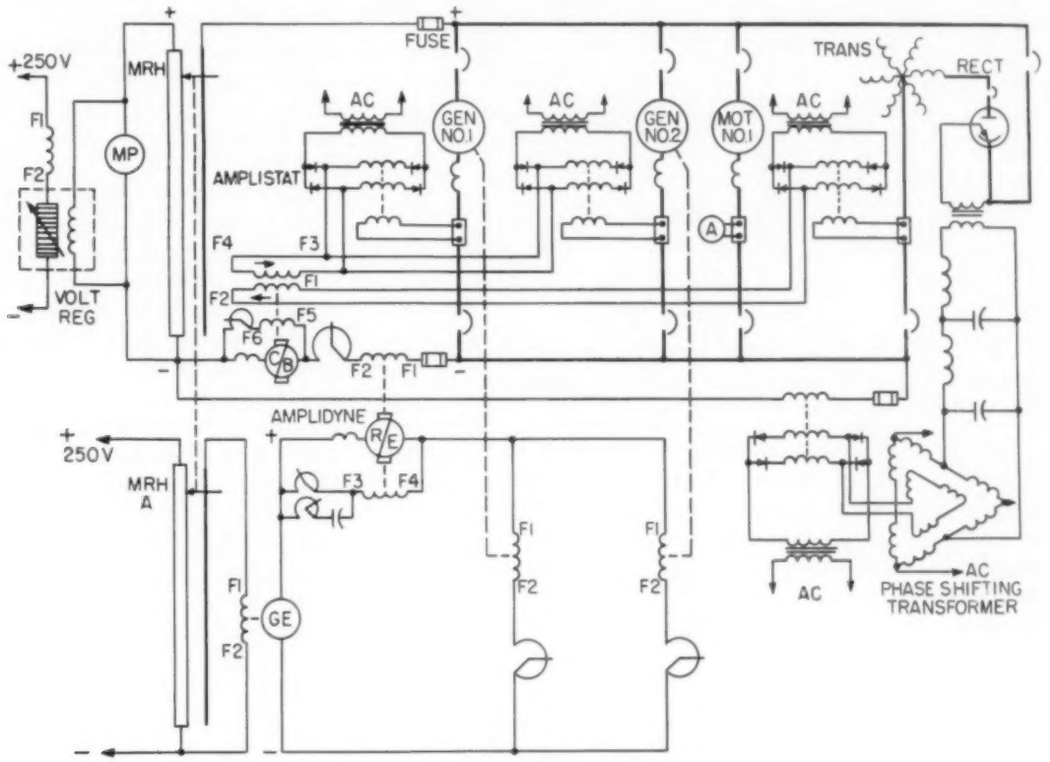


Figure 8—Sketch shows voltage regulation and load balance with both generators and rectifiers.

This pumpback current cannot occur with power rectifier equipments. The magnetic amplifier is therefore an ideal device for the control of rectifiers, and it has been used with them most successfully for many years.

This device used as a pre-amplifier with rotating type of regulators makes an excellent combination. Such a combination could be used for the vernier portion in any of the regulating schemes so far noted.

Figure 8 shows a magnetic amplifier used for voltage control of a rectifier and for load balance with generators in parallel on a common bus system. Here the load currents of all generating units are compared through the field windings at an exciter (CB). If the rectifier load is proportionately high, the generator voltage is increased. Conversely if the generator load is higher, the voltage of both generators is reduced until proper load balance is established. The rectifier voltage is maintained equal to the master pilot voltage at all times. The load comparison circuits are electrically isolated and when a generator is disconnected from the bus, the load is automatically redivided among the remaining units.

Two such equipments are in process of manufacture for existing installations. A third installation is under consideration for a similar modification.

Three installations using rectifiers only on the finishing mill bus have been made in this country. Magnetic amplifiers similar to the above are used, and full phase retard of voltage is provided for use in starting the motors from rest. Two of these installations have been in operation for several years.

Mercury arc rectifiers on hot strip mills have been described in previous AISE papers. We need here only to briefly recall the main advantages and disadvantages as compared with motor-generator sets.

The main advantages are:

Lower first, installation and maintenance costs.

High momentary load capability.

There can be no contribution of fault currents to a-c system.

The main disadvantages are:

Lagging power factor.

Cannot regenerate power.

D-c volts vary with a-c volts, except as overcome by use of regulators.

Operation at greatly reduced voltages is not economical, however, transformer taps can be provided for voltage adjustment with or without load.

There are a few characteristics of rectifiers which should always be given special consideration on hot mill installations. When rectifiers are used on a common

bus system, high speed circuit breakers may not be suitable to sectionalize the bus on faults because arc backs may cause unnecessary tripping of the sectionalizing breakers in normal operation. Also, the rate of current rise on bus faults is greater with rectifiers than with motor-generator sets. However, the response of voltage regulating systems on rectifiers to sudden load change is faster than generators.

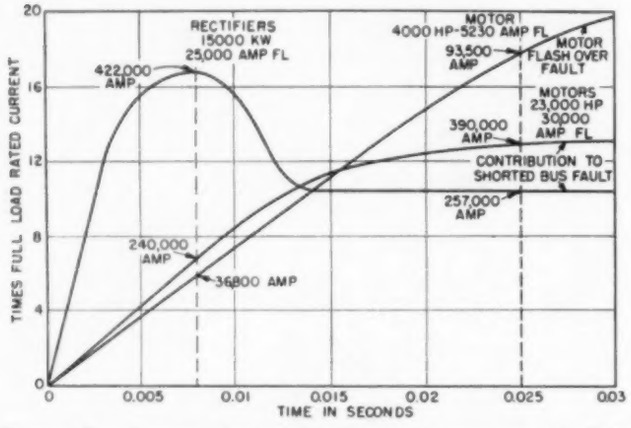


Figure 9 — Curves give calculated fault currents for 600-volt hot strip mill bus.

Figure 9 shows how fault currents vary with time on one particular installation. These calculated values are expressed in multiples of full load ratings. The rectifier contribution to a bus fault reaches a maximum of nearly 17 times full load rating in 0.008 seconds. The contribution by rotating machines to such a fault has a slower rate of rise — reaching about seven times machine rating in 0.008 seconds. However, if the fault is maintained, the rectifier contribution levels off to a little over 10 times full load rating, whereas the rotating machine contribution continues to rise to about thirteen times full load rating in 0.025 seconds. If, therefore, only rotating machines were involved and we desire to limit the machine contribution to a bus fault in the order of some 250,000 amperes, we could use high speed breakers to split the bus in sections, then relay on semi-high speed breakers to isolate the individual machines. Some installations using this arrangement are now in operation.

A main drive rotating machine is usually able to withstand mechanical forces created by its own terminal short circuit. This represents current in a range 10 to 15 times full load rating. One of the most common faults is a commutator flashover. Such a flashover can be caused by machine contribution to a fault or even by a too sudden change in terminal voltage.

Figure 9 also shows the rate of current rise in the commutating and pole face winding of a 4000-hp motor with a commutator flashover. Because of machine winding inductance there is no appreciable difference in fault current whether the bus is fed by motor-generator sets or rectifiers. However, if such faults are not interrupted before the current reaches 10 to 15 times normal, we may expect damage to the series windings. Fast interruption of current by highspeed breakers may cause abnormal surges in the machine inductive circuits and may even be the cause of flashovers. Conversely slower interruption by semi-high speed breakers may permit excessive current rise.

Figure 10 shows an arrangement of motor circuits using a high-speed breaker (JR) shunted by a surge protective resistance. When the JR breaker opens from flashover at B the resistor is inserted to limit the line current and the semi-high speed breaker (MC5) in opposite polarity is opened. This two-step interruption keeps both current and voltage surges within reasonable limits. The arrangement appears to give adequate protection for the motors, and permits the use of semi-high speed breakers elsewhere in the circuit. Several installations have been made using this arrangement of breakers.

Rectifier arc backs are successfully interrupted by individual anode breakers. Occasional operation of these does not interfere with continuity of power supply nor voltage regulation. This is true because only one pole of the anode breaker may open and it is automatically reclosed.

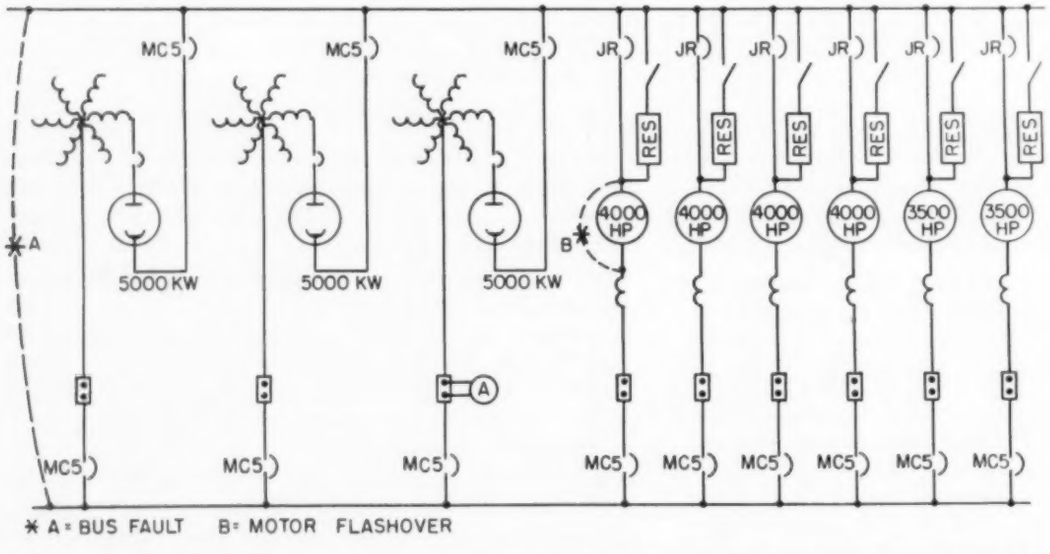


Figure 10 — Common bus arrangement uses high speed and semi-high speed breakers.

SYNCHRONOUS ROUGHING MILL DRIVES

The lagging power factor resulting from the use of rectifier equipments may be satisfactorily offset by using synchronous motors on the roughing mill drives.

If the slabs are of sufficient length to be in a mill five seconds or more, wound rotor motors with flywheels serve no advantage in reducing power demand peaks. Synchronous motors then have the advantage in lower cost, higher efficiency, and better power factor.

In those cases where full voltage start must be used, low jogging or inching speed can be obtained by applying a low d-c voltage alternately to the three stator leads. Figure 11 shows a simple method for use on a 6000-hp, 360-rpm, 6600-volt motor. When the main breaker is de-energized, the d-c potential may be alternately applied to the three stator leads in steps. There are a total of 12 steps controlled by a timer. Each step shifts the stator flux 30 degrees. Since the motor has 20 poles, one mechanical rotation will require 120 steps. Reversing is accomplished by reversing the direction of sequence timer. The first of these was put in operation in 1937.

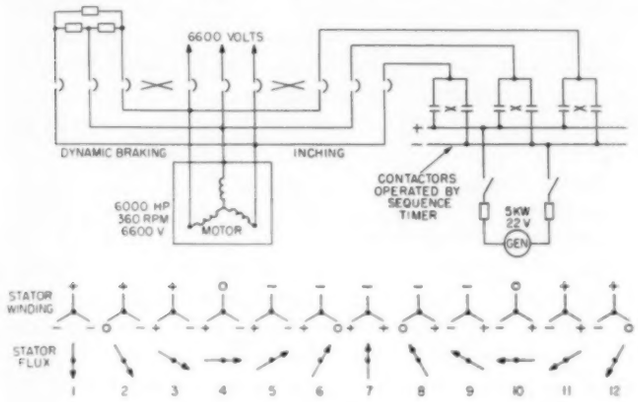

6600 VOLTS
DYNAMIC BRAKING
INCHING
CONTACTORS OPERATED BY SEQUENCE TIMER
6000 HP 360 RPM 6600 V MOTOR
5KW 22 V GEN
STATOR WINDING
STATOR FLUX
1 2 3 4 5 6 7 8 9 10 11 12

Figure 11 — Inching control shown is used on a synchronous motor.

POWER FACTOR REGULATOR

When a large portion of the total power is supplied through synchronous machines, it becomes desirable to control power factor, reactive kva or some combination thereof. The ratio of kw to kva defines the term power factor. On a balanced three-phase system this ratio is a measure of the phase angle between load current in one line to the voltage across the other two lines.

Figure 12 shows a very simple system which can be used on any synchronous motor where it is permissible to adjust its excitation according to load conditions.

A rheostat is used to manually adjust the field of the synchronous motor exciter to give the desired average value of a motor field excitation.

If now we apply line voltage to the stator of a phase shifting selsyn, we obtain a voltage on its rotor which can be rotated to a phase angle that leads or lags line voltage. Then if we compare this voltage with the magnitude and phase angle of line current we obtain a resultant voltage which can be rectified and used to control motor excitation. The manner in which these two quantities are compared determines whether the resultant voltage represents motor power factor, rkva or a combination of the two.

The voltage of the synchronous motor field is also compared with preselected maximum and minimum reference voltages through an auxiliary field on the RE machine. Rectifiers in this field circuit permit current to flow in the control field whenever the field voltage tends to go above or below the preselected limit. This in turn protects the motor from the effects of over and under excitation.

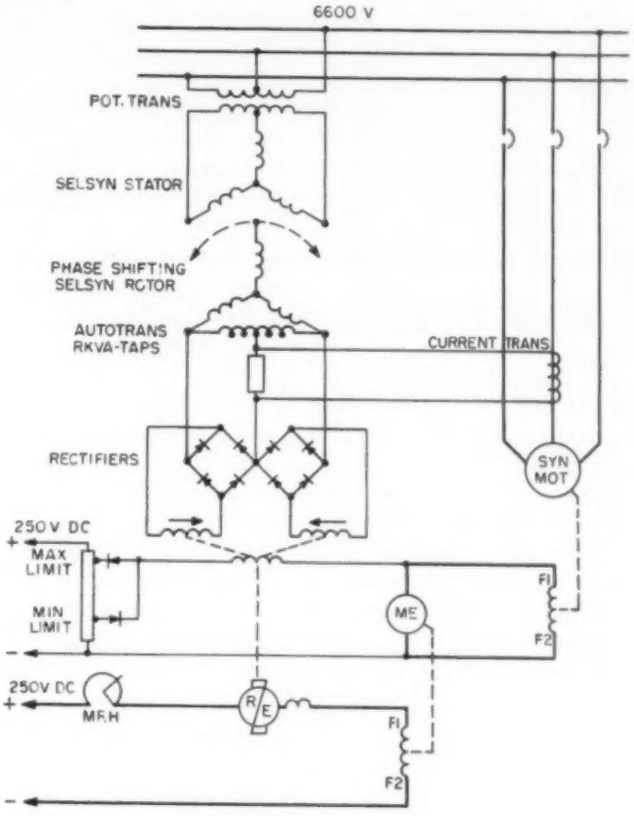


Figure 12 — Diagram shows one method of regulating power factors for synchronous motors.

Power factor adjustment is accomplished by adjustment of the selsyn rotor position and reactive kva control is adjusted by the tap switch on the current transformer connection.

As in all the previous systems of control, the regulating unit incorporates only a vernier range above and below some manually preset operating level. This arrangement provides very accurate regulation with stable operation.

SUMMARY

The electric systems for a modern hot strip mill are made up of a great many components. The author has attempted to describe only those which seem to be of mutual interest, define a future trend, and are of special concern to mill people at the present time:

1. The width gage — one of the youngest in our family of rolling mill tools.
2. The X-ray gage — a "must" beyond all reasonable doubts.
3. Bus voltage regulators — a necessary requirement for all systems.
4. Speed regulators — assure improved operations.
5. Individual generators — the first installation to establish a possible future trend.

6. Magnetic amplifiers — a versatile static amplifier of proven merit for nearly all regulating systems, load balance schemes, etc., used separately or in combination with rotating regulators.
7. High speed and semi-high speed breakers — essential for protection of equipment.
8. Mercury arc rectifiers — advantageous for complete or partial power supply to finishing mills.
9. Synchronous motors for roughing mills — advantageous for cost, efficiency, and power factor.
10. Power factor regulation — a versatile method of automatic control of reactive kva.

All of these do in some way or another contribute to the production of better steel faster — and more economically.

DISCUSSION

PRESENTED BY

W. R. HARRIS, Manager, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

J. D. O'ROARK, Assistant to Manager, Service and Maintenance, Weirton Steel Co., Weirton, W. Va.

H. H. ANGEL, Electrical Engineer, Bethlehem Steel Co., Bethlehem, Pa.

R. E. MARRS, Steel Mill Engineering, General Electric Co., Schenectady, N. Y.

W. R. Harris: First I would like to comment on the voltage regulating scheme for the common bus system as shown in Figure 4 of the paper. I do not believe that the ohmic drop exciter shown in this scheme is desirable for the following reasons: (1) it adds another machine to the circuit which will require periodic maintenance, and (2) with a modern high gain voltage regulator, very close regulation of bus voltage can be obtained without it.

For such a system, the change in voltage due to generator regulation is $-\frac{IR}{1+A}$ in which IR is the regulation of the generator and A is the system gain. With a normal system, where several generators are operated in parallel, six to eight per cent regulation is provided so that they properly share the load. With a system gain of 25 to 50, which any good system will have, the no-load to full load regulating error will be between one-third and one-eighth of one per cent. Also, modern bus layouts have very little drop, and so compensation is not needed for bus drop. For these reasons I would recommend that the ohmic drop exciter be eliminated.

I would next like to comment on speed regulation of hot strip mill motors by regulators and the proposed scheme as shown in Figure 5 of the paper. Such schemes have been proposed for a number of the older installations where better motor speed regulation is desired. Such techniques are well known and modern systems would use either the rotating or the magnetic amplifier type of regulators. However, most of the newer mills are obtaining excellent results with the motors designed for good inherent speed regulation. Some of these mills are operated with series exciters whose effect is changed with motor field strength by a separate circuit on the motor field rheostat. Such a system will result in a motor speed regulation of between one and one-half and two and one-half per cent which gives very excellent operating results. We disagree with Mr. Marrs' remarks that the response time of these exciters is slow and that they do not have suitable characteristics for all load conditions at various operating speeds. With modern application techniques, we have obtained very excellent results with them and saved the complication of a speed regulator.

I would like to point out that steady-state speed regulation of the finishing stand motors is of utmost importance to hot strip mill operation. Maximum attention must be paid to this if you are to get a well behaved mill drive which will permit high production rates with minimum attention from the operators.

Mr. Marrs' comment on the possibility of individual generators for hot strip mill drives is well taken as proven by experience with tandem cold reduction mills. However, the overall generating capacity will usually be greater. This is shown by Table I for common bus mills in which the diversity factor is the kilowatt generator capacity divided by the kilowatts necessary to supply the motors assuming 93 per cent motor efficiency.

TABLE I

Mill No.	Width	Generator or rectifier total kw	Total hp	Diversity factor
1	79	18,000	28,000	80.4
2	56	12,000	18,500	81.0
3	68	18,000	23,500	95.5
4	80	21,000	25,500	102.7
5	80	18,000	25,500	88.0
6	66	15,000	19,500	96.0
7	66	15,000	23,000	81.4
8	80	18,000	28,000	80.3

The tabulation shows that in most cases the individual generator system will require more generator capacity and so will be more expensive. There is a possibility that going part way and splitting the bus into about three sections may be attractive. This will reduce the short circuit capacity quite materially and will allow almost the full flexibility of reduction in voltage afforded by the individual generator system. We have made one such installation in an east coast plant where six direct current motors totaling 29,000 hp are supplied with power by a total of 24,000 kw of mercury arc rectifiers. Three buses are used with two motors, and two 4000-kw rectifiers are on each bus. The bus is permanently split: no tie breakers are used. Initial operation has shown that this arrangement is flexible and gives highly satisfactory results. Sensitive magnetic amplifier voltage regulators are used to hold the voltage of each bus very closely.

I would like to insert a word of caution in using calculated fault currents for direct current machines. It is very difficult to get satisfactory short circuit calculations on d-c systems without making several assumptions. This is due to several factors not subject to rigorous prediction by calculation, such as bus and armature inductance, the time at which saturation in the interpoles occurs, and the effect of short circuited arma-

ture turns under the brushes which demagnetize the main field. Figure 13 is plotted from an oscillogram of a short circuit on a 1500-kw, 750-volt generator used for laboratory testing. The powerful demagnetizing effect of short circuited turns under the brushes and armature demagnetization can be seen from the trace showing field amperes. In an effort to hold the flux in the machine constant, the shunt field current is inductively kicked from 25 to 75 amperes as the short circuit is applied. Also, a dead short circuit (bolted fault as it is often called) is seldom obtained in practice. There is

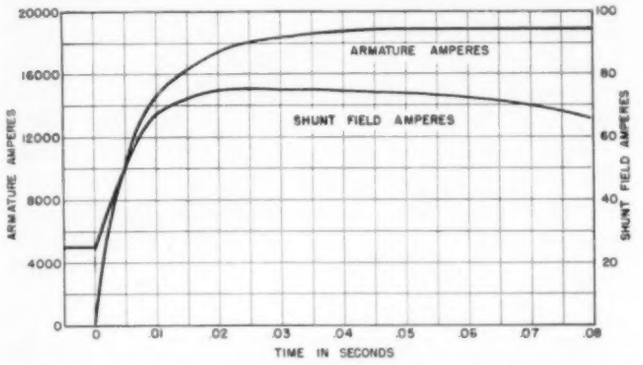


Figure 13 — Data shown was obtained from an oscillogram of a short circuit on a 1500-kw, 750-volt generator.

usually some fault impedance involved which has a definite current limiting effect. We have quite a number of common bus installations in service using the CHM breaker as both motor and generator breaker. This is a semi-high speed breaker and we have found that it is able to handle the faults experienced in practice very successfully. To date we have not found it necessary to resort to high speed breakers.

J. D. O'Roark: The use of the type JR d-c breaker for protecting high current d-c bus structures was mentioned as a new practice. It is to be recalled that you furnished type JR breakers on a combination of rectifiers in parallel with motor-driven generators on a hot strip mill application back about 1940 and later decided not to utilize the JR breakers, for which no other use was found and the JR breakers were subsequently scrapped.

We wish to raise the question as to whether some flexibility may be sacrificed through the use of individual generators on hot strip finishing stand drive motors. With existing common bus systems, it oftentimes is rolling practice to lighten up on a stand with worn out rolls and take heavier draft on a succeeding stand which has good roll surface. This of course shifts the motor load from stand to stand and may on occasion exceed the capacity of the individual generator unless sufficient capacity is provided for this purpose.

The use of rotating regulator equipment in connection with controlling and matching mill motor speeds has been generally very satisfactory. However, on some rotating regulator equipment, the design engineer has not incorporated sufficient capacity in the unit to take care of currents required during forcing and accelerating periods, thereby resulting in severe sparking at the brushes during these periods, with resultant burning of the brushes and commutator, developing of high brush drop and loss of good control performance. This is an important consideration and should not be overlooked.

H. H. Angel: I think that Mr. Marrs has given us a record of some very good schemes to apply on new jobs. Some of these might be studied very carefully for use in applying to existing jobs, say on hot strip and cold strip mills, where certain of the present controls might not be operating as well as you would like to have them.

R. E. Marrs: Mr. Harris' comment on the ohmic drip exciter is quite true for most common bus systems. A modern high-gain regulator does give very close regulation of the bus voltage without the ohmic drop exciter. The desired end result is however close regulation of motor speed. We have found in our analogue computer studies of regulating systems, that when a high-gain and high speed of response regulator is desired, the use of such an exciter provides the means of obtaining the stability adjustment necessary to obtain the fastest system response. It is a feature that has proved desirable on the high speed tandem cold mills. The actual load on these machines is very small compared to their rating, and the maintenance becomes an almost negligible item. The basic idea also lends itself to use of either the magnetic amplifier or rotating amplifiers. When or when not to use them therefore becomes a matter of what degree of refinement is desired for the overall regulating system.

With reference to the speed regulation of the mill drive motors, the first requirement is to have a motor with good inherent speed regulation. Our present day motor designers can point with pride to the performance of a modern mill motor. Yet we cannot expect the same close speed regulation for all values of load and for all speeds within the range of motor rating. We know of one wide hot strip mill in the Chicago area where the operators are provided with a means to adjust the amount of speed droop with load. This is done with the intent to minimize and equalize the droop of all motors to approach what a speed regulator could do. Series exciters, as they have been used, adjust the excitation of an auxiliary winding on the motor field in proportion to the load current. This adjustment can be varied for various values of main field adjustment but sometimes a motor with a particular design characteristic will require an auxiliary field excitation at half load as great as or greater than required at full load. Convenient and practical means to do this are not available. Furthermore, these series exciters have response characteristics like an ordinary d-c machine. They merely adjust their voltage to some present level dictated by load condition. There is no feature which rapidly forces their voltage to specified values. Their overall time of response is therefore slow when compared with rotating regulators and magnetic amplifiers used for the same application or as speed regulators.

Many of the common bus systems in use today have a connected motor load greater than the generating capacity, however, the trend is toward equalizing this ratio. The use of individual stand drives may necessitate some small sacrifice in the diversity factor. However, the split bus arrangement using a pair of motors and rectifiers for each section that Mr. Harris describes with the 29,000-hp connected load and 2400-kw of rectifiers has a diversity factor of 103 per cent.

This leads to the question of flexibility raised by Mr. O'Roark. If the trend is toward diversity factor

such as 100, then from the standpoint of load it does not matter whether you use individual generators or a common bus system.

The use of high speed breakers (even with current limiting resistors) for protection of d-c apparatus is not new. They were used many years ago on some rotary converter installations. The advent of mercury arc rectifier equipment and the magnitude of short circuit levels on modern mills has made us all a little more circuit breaker conscious. The installation to which Mr. O'Roark refers was the first mercury arc rectifier built for the main drives of a hot strip mill. Anode breakers were not then available, and the high speed breakers were felt necessary as a protection against arc back. The advent of World War II delayed installation of this equipment. Anode breakers later became available and were installed with the original equipment. The high speed cathode breakers then became less necessary but I believe they were retained perhaps more as a line disconnecting device than for protection against faults. It is my understanding that the installation space available required them to be mounted in an undesirable location. This location made them vulnerable to loosening concrete and they were then removed from service. With anode breakers some engineers feel that cathode breakers are not necessary. It seems here again to be a matter of the refinement and protection desired as to whether or not you use them. Instead of scrapping the original two breakers, perhaps four more should have been acquired for use in each of the motor line circuits.

Mr. O'Roark makes note of another very important consideration in the design of adequate machine ratings to handle the current and voltage required during regulator forcing. This is probably not a great problem on hot strip mill installations. However, there are many drives where the rate of rise of current and voltage under transient conditions must be thoroughly studied. The main drive machines as well as the regulating and excitation machines may have to be specially designed to commutate the rapid rates of current changes produced by a modern regulating system.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, March 29, 1954 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Adjustable Speed Drives Utilizing the Eddy Current Clutch and the Magnetic Amplifier," by R. J. Weesner, Assistant Chief Application Engineer, The Louis Allis Co., Milwaukee, Wis.

Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Tuesday, March 9, 1954 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Instrumentation as Applied to Steel Plants," by J. R. Greene, Manager, Steel and Ceramics Industrial Div., Brown Instrument Div., Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

Hotel Sheraton, 715 Delaware Avenue, Buffalo, N. Y.

CHICAGO SECTION

Tuesday, March 2, 1954 — Dinner 6:15 P.M., Meeting 7:45 P.M.

"Adjustment and Maintenance of Magnetic Amplifiers," by Paul M. Fischer, Electrical Engineer, Cutler-Hammer, Inc., Milwaukee, Wis.

Phil Smidt's Restaurant, 1205 N. Calumet Avenue, Hammond, Ind.

CLEVELAND SECTION

Tuesday, March 16, 1954 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Use of Strain Gauges for Evaluating Stresses in Structures," by W. A. Black, Chief Electrical Engineer, Steel and Tube Div., Republic Steel Corp., Cleveland, Ohio.

University Club, 3813 Euclid Avenue, Cleveland, Ohio.

DETROIT SECTION

Tuesday, March 9, 1954 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"More Production Through Chemical Maintenance," by A David Nesbitt, Service Engineer, Dowell, Inc., Detroit Mich.

Horace Rackham Educational Memorial, Detroit, Mich. Dinner — Parlors "E," "F," and "G," Meeting — "Small Auditorium."

PHILADELPHIA SECTION

Saturday, March 6, 1954 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"Increased Rod Production by Conversion of a Two-Strand Rolling Mill to Three-Strand Operation," by C. H. Burden, Chief Project Engineer, and W. E. Zelley, Divisional Plant Engineer, John A. Roebling's Sons Corp., Trenton, N. J.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

Tuesday, March 9, 1954 — Meeting 2:30 P.M.

"Safety Through the Finishing Line," by W. L. Jones, Jr., Safety Engineer, and C. E. Pritchard, Superintendent of Mills, Alan Wood Steel Co., Conshohocken, Pa.

This is a joint meeting with the 20th Annual Regional Safety Conference, North Garden, Bellevue-Stratford Hotel, Philadelphia, Pa.

PITTSBURGH SECTION

Monday, March 8, 1954 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"The Economics of Replacement in the Steel Industry," by G. G. Beard, President and General Manager, United Engineering and Foundry Co., Pittsburgh, Pa.

Alumni Room, University Club, University Place, Pittsburgh, Pa.

YOUNGSTOWN SECTION

Monday, March 22, 1954 — Dinner 6:30 P.M., Meeting 8:00 P.M.

Paper to be announced later.

Mahoning Country Club, Girard, Ohio.

RUST Slab REHEATING Furnaces

TWO TRIPLE-FIRED, END CHARGED, END DISCHARGED, CONTINUOUS REHEATING FURNACES INSTALLED BY RUST IN A PENNSYLVANIA HOT STRIP MILL

heat 160 tons of cold steel slabs per hour

The whole job is ONE job with a RUST PACKAGE CONTRACT

One contract covers everything . . . from blueprint through start up. Rust assumes responsibility for design, manufacture, erection, and is prepared to undertake all phases of the work with its own forces, including wiring and piping. This results in substantial savings . . . One profit instead of pyramiding ones which accrue where many subs are employed.

The outstanding feature of these Rust Furnaces is the completely automatic temperature and combustion control, with easy operation from a centrally located panel board. Slabs are heated in two triple-zone gas furnaces. Burners at top and bottom heat slabs to rolling temperature at a rate of about 160 tons of cold steel per hour (80 tons per furnace). Furnace temperature ranges from 1650°F. at the entry end to about 2400°F. at the discharge end.

Flexibility is achieved by simply changing the fuel firing rate in the heating zone. The result is HIGH TONNAGE OUTPUT with MINIMUM FUEL CONSUMPTION. Aiding this high capacity and economy of operation are Rust Recuperators which preheat the air for combustion. This type of Rust Furnace is used by virtually all of the strip mills in the world. Rust also builds all other types of metallurgical heating furnaces (designed for any fuel). For either new or modernization projects let Rust quote on your requirements.

Rust Furnace Company

Pioneers in Furnace Design

Rust Building • Pittsburgh, Pa.

▲ ON May 31, 1953, the first atomic engine in the nation's history turned the propeller shaft of a "dry land submarine" built in the middle of an Idaho desert.

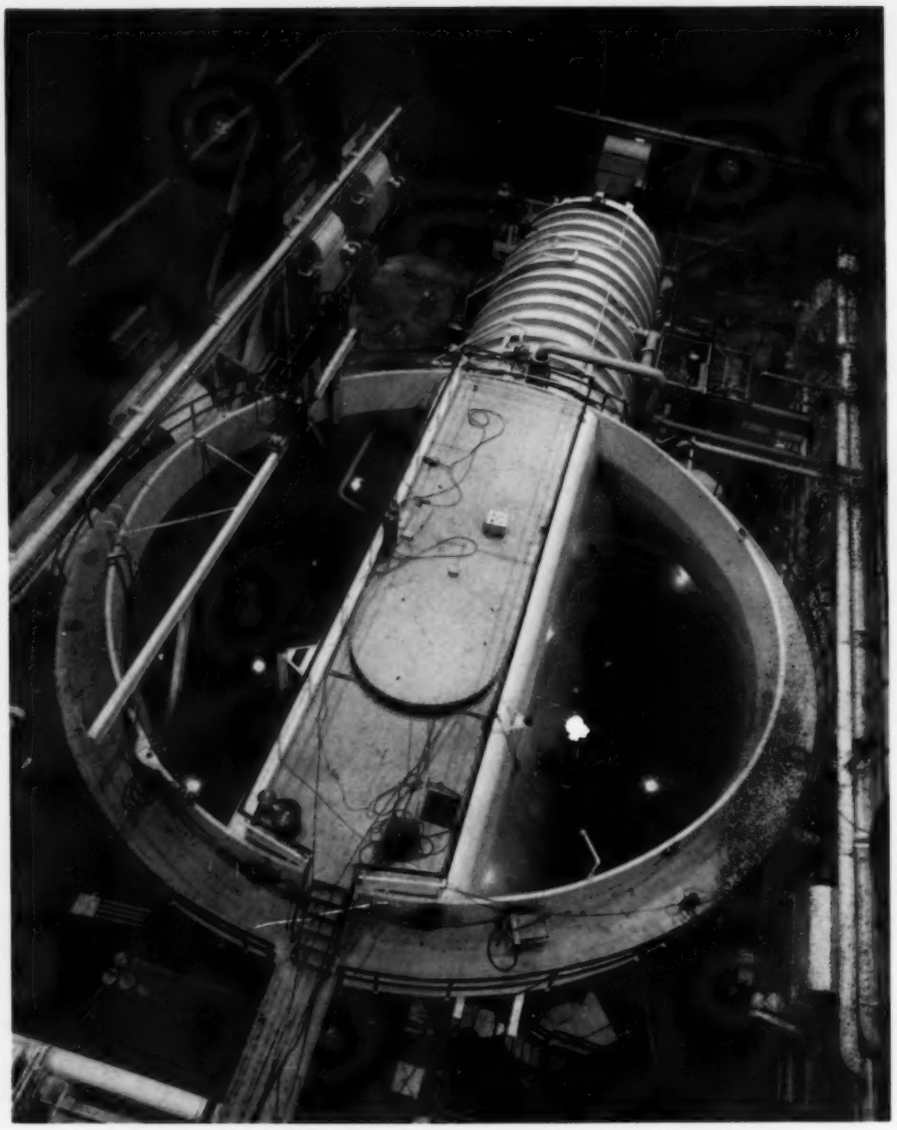
This history-making engine, built by Westinghouse Electric Corp. under contract with the Atomic Energy Commission and in cooperation with the AEC's Argonne National Laboratory, was the land-based prototype or experimental model (Mark I) of the nuclear power plant (Mark II) that will propel the first atomic submarine, U.S.S. Nautilus.

The Nautilus was launched Thursday, Jan. 21, 1954, by the Electric Boat Division of General Dynamics Corp. at Groton, Conn.

The accompanying photographs, just cleared for release, provide a good look at this installation where the first nuclear power plant ever to produce power in "substantial" quantities now is in test operation.

The desert-bound atomic engine is a full-sized power plant installed inside two sections of a submarine hull. The reactor compartment is surrounded by its own private ocean—a large sea tank full of water.

The second atomic engine, Mark II, also built by Westinghouse, will make the Nautilus an around-the-world submarine, capable of cruising submerged great distances at speeds above 20 knots.

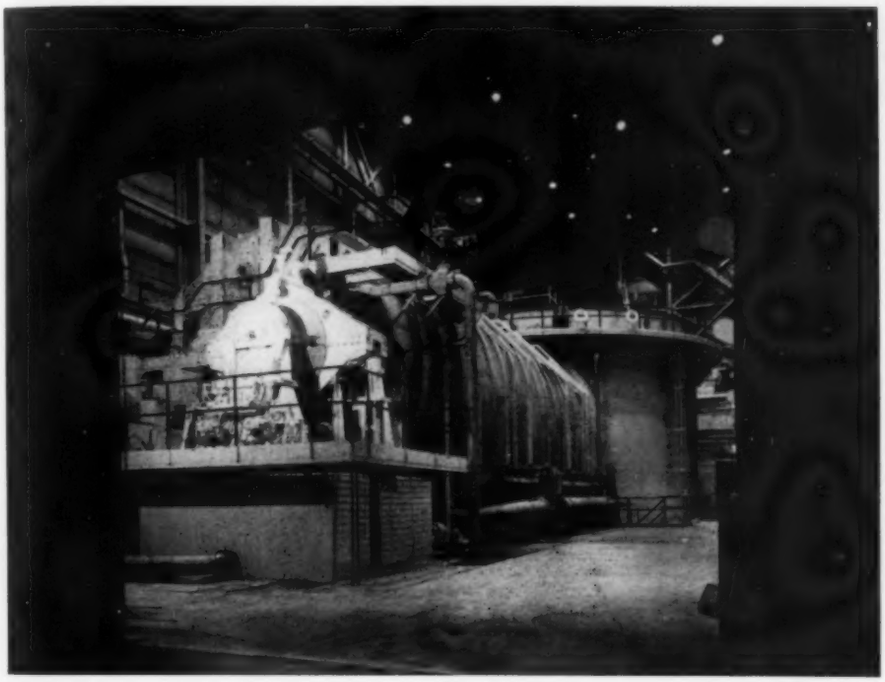


▲ The first atomic submarine engine, contained in the land-based submarine hull shown here, was generating power when this picture was taken. This picture was taken inside the main building at the submarine thermal reactor test site. The large sea tank is about 50 ft in diameter and almost 40 ft high. The hull passes through the tank so that the reactor compartment is located within the tank and completely submerged in water. The tank's water capacity is about 385,000 gal.

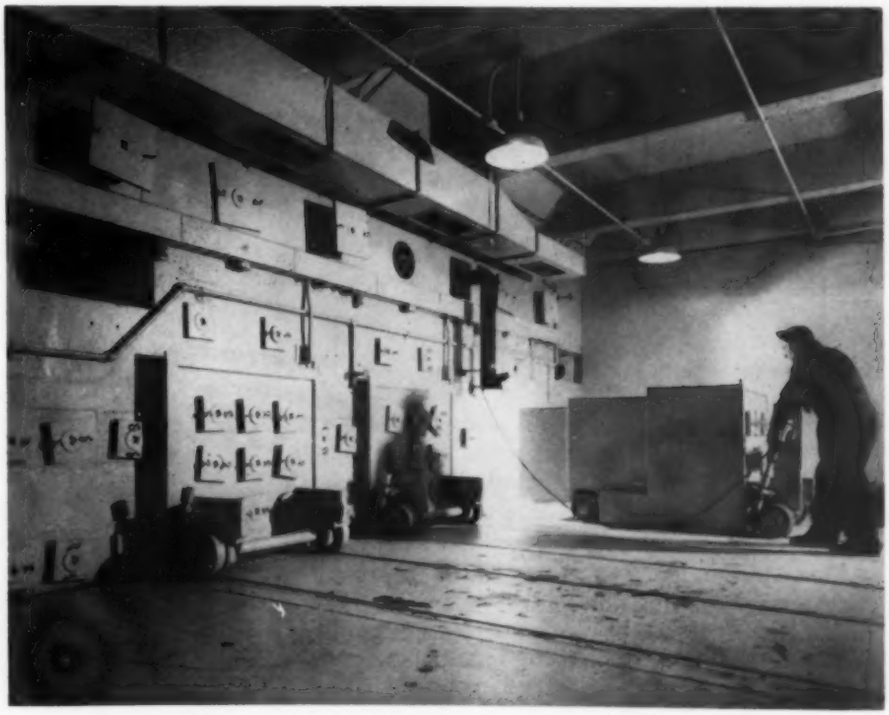
◀ This 2,000,000-gal "lake" in the middle of a southeastern Idaho desert is used to cool water heated by the world's first atomic submarine engine. Designed to carry off heat which, in an ocean-going sub, would be dissipated at sea, the lake is actually a spray pond. Shown in the background is the steel and concrete building housing the atomic engine. The pond is equipped with 288 nozzles and can cool 22,500 gpm of water. The pond also provides cooling water for steam condensers, for the "water brake," which absorbs power developed in the atomic engine, and other heat producing equipment.

SUBMARINE TO BE FIRST USER OF ATOMIC POWER

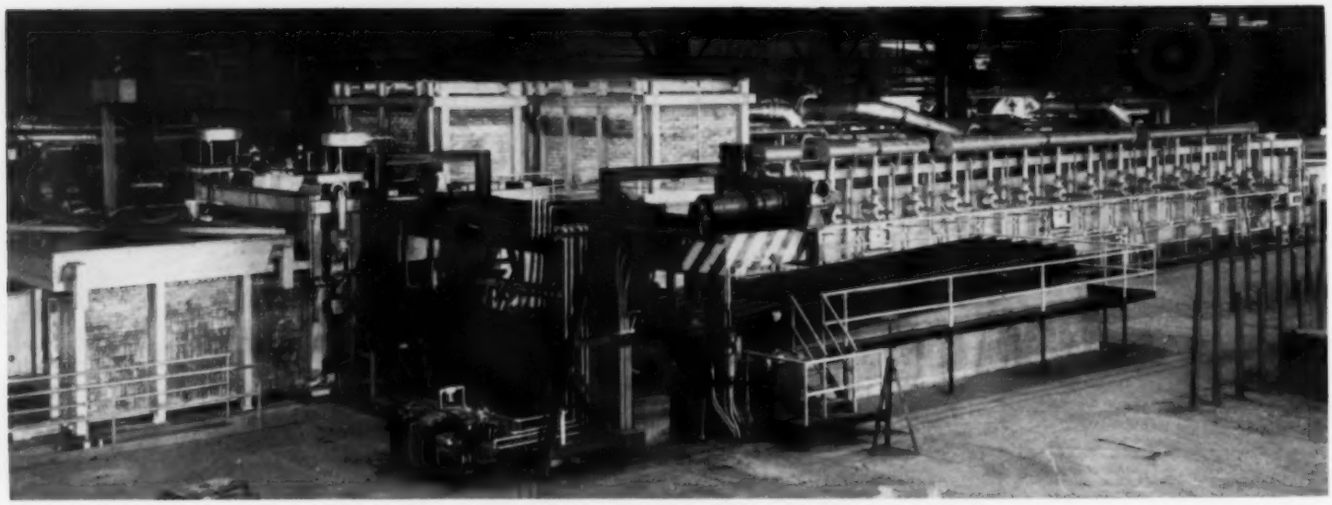
▲ One of the most unique tools of the atomic age is the "hot cell." This one, located at the AEC test site, has concrete walls seven ft thick and will enable scientists to work on radioactive materials and equipment without danger. General purpose manipulators, with mechanical claw-like hands, are operated by remote control from outside the cell. When this picture was taken, Westinghouse technicians were preparing a component for installation in the Mark I power plant. The hot cell facilities were used for this purpose mainly because its ventilation system kept the air in the room "hospital clean." If this component were radioactive, the manipulators would take over. The cell is linked to the deep water pit by means of a connecting elevator. The floor of the elevator becomes part of the floor of the cell when it is in the "up" position.



▲ Inside the hull of this "indoor submarine" located in the middle of an Idaho desert is the first atomic engine ever to produce substantial quantities of power. This nuclear power plant (Mark I) was built for long-range testing and operation and is an experimental model of the actual engine (Mark II)which will drive the atomic submarine, U. S. S. Nautilus.



Measuring four ft square at its large ▶ end and seven ft through its center, the door, or plug, is one of the six of equal size through which Westinghouse scientists may enter the "hot cell" at the Atomic Energy Commission test site. A seventh door is much larger and weighs about 25 tons. Like the smaller ones, it is made of steel and concrete. The hot cell is used to handle and test radioactive materials and equipment. Its seven-ft thick walls afford protection from the deadly radioactivity.



Overall view of furnace shows inlet and charging equipment.

TUNNEL FURNACE BUILT FOR BILLET HEATING

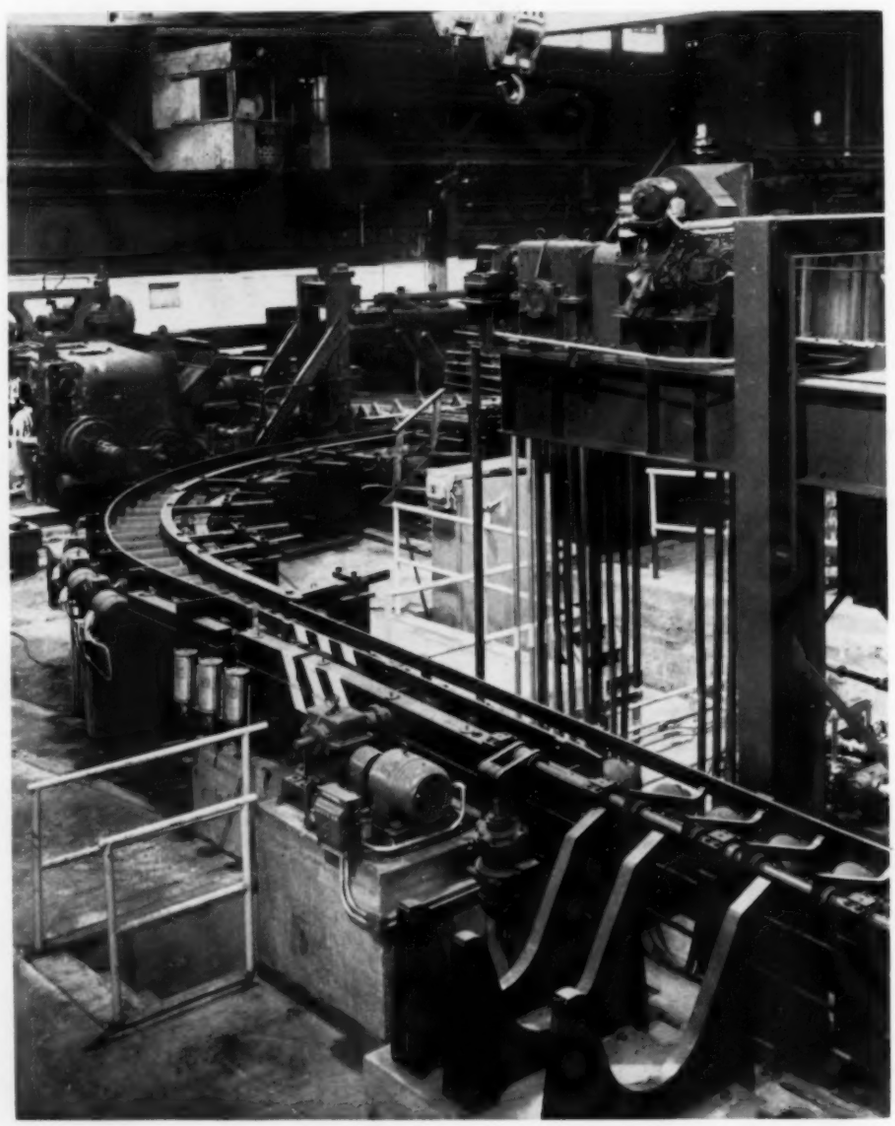
▲ THE first tunnel-type furnace to be used exclusively for steelmaking was completed at the Timken Co.'s mill in Canton, Ohio, in January, 1954. Estimated to cost $500,000, the heating capacity of the furnace is fifty tons per hour. Used extensively in the ceramic industry, the tunnel-type furnace with its continuously moving hearth, is an important innovation in steelmaking. The use of the tunnel-type furnace for the heat treating of steel actually started during World War II as an emergency measure when the Timken Co. contracted with a local ceramic concern to perform this work.

The roll down furnaces, which the tunnel furnace replaces, required 2,900,000 Btu per ton of steel heated. The tunnel-type furnace is expected to reduce this figure by 20 per cent. Not only will fuel consumption be markedly reduced, but scale loss will also be greatly diminished. Formerly, seven men were required to operate the replaced roll down furnaces, where now only two men are required to operate the new tunnel furnace. Substantial savings then are expected in fuel consumption, scale loss and man-hours.

Temperature, air-fuel ratio and furnace pressure are all controlled automatically. Rounds are also automatically charged into the furnace with a tong-type automatic charging machine, one or two at a time, depending on whether single or double rows of billets are wanted.

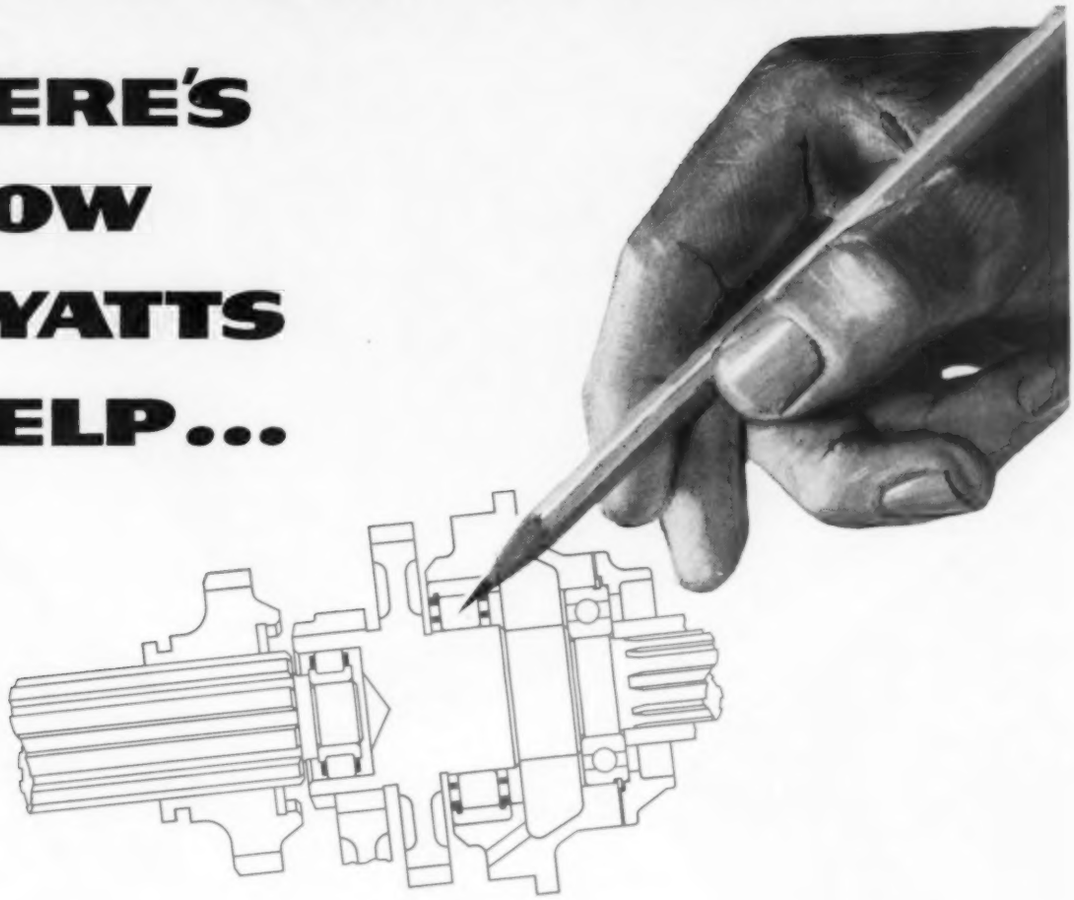
Billets are carried through the furnace on cars 12 ft wide and 11 ft 9 in.

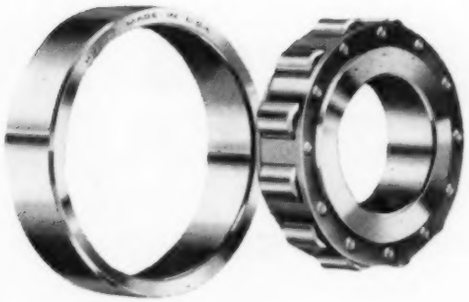
Outlet conveyor from furnace. Cars return to other end of the furnace at a lower level.

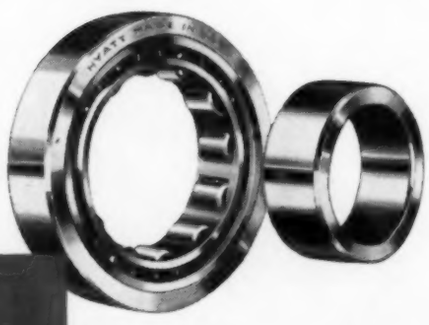


when LIMITED SPACE is a design factor

HERE'S HOW HYATTS HELP...







Sometimes a fraction of an inch is the difference between a simple design modification and costly re-tooling. And the engineer who is thoroughly familiar with Hyatt Roller Bearings will know a lot about how to save those fractions. He'll know, for example, that to gain greater shaft rigidity with the same size housing, he need only check his Hyatt catalog for a separable inner race type of bearing. This type—available in a wide range of sizes—may be applied with the rollers operating directly upon the surface of a suitably hardened and ground shaft. Thus, a larger-diameter shaft may be used without sacrificing bearing capacity, or a larger-size bearing may be used without changing the size of the shaft. For a copy of Hyatt's latest catalog, No. 150, write to Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

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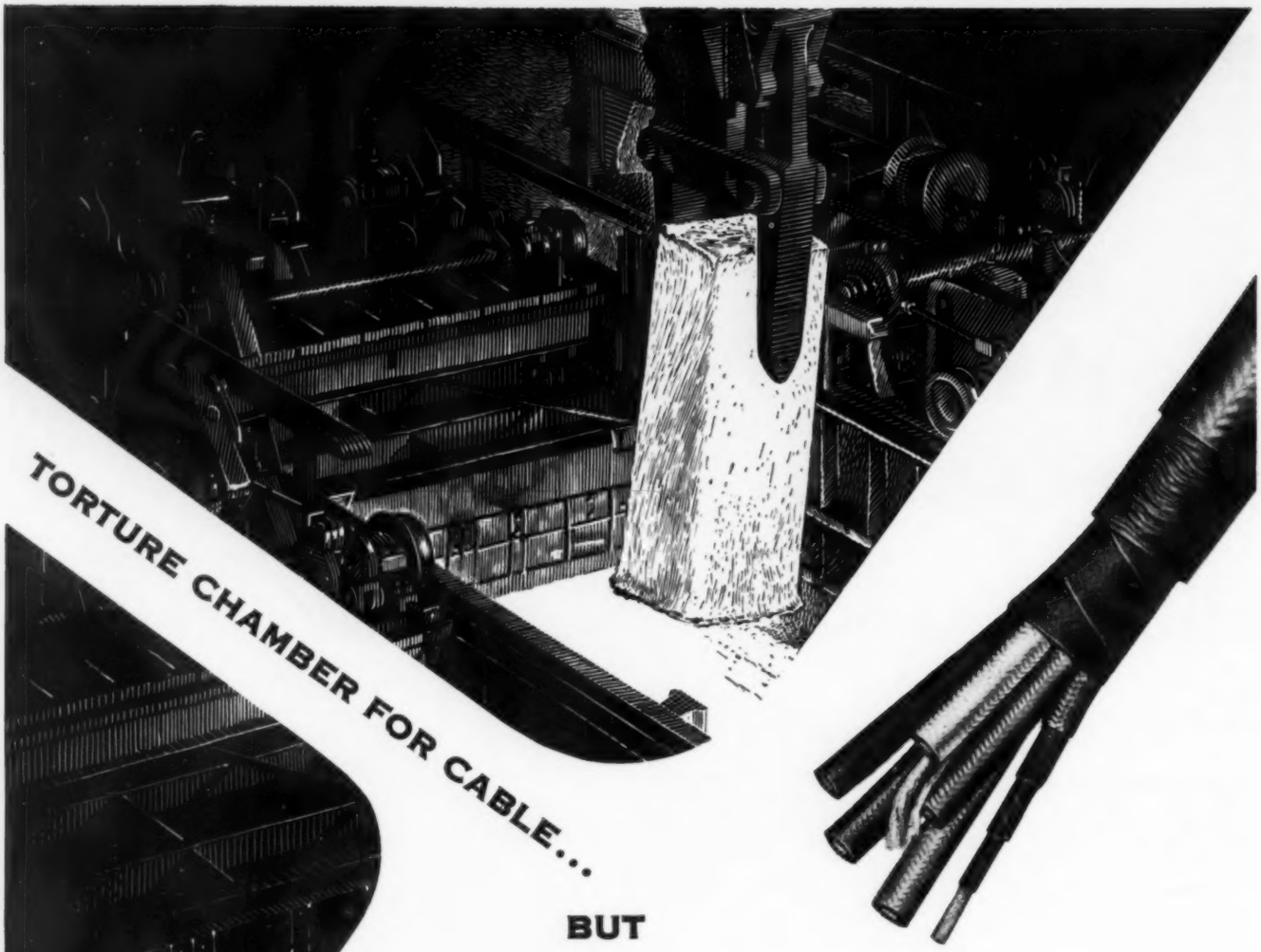

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long, at speeds which can be adjusted from six to thirty-two inches per minute. Eleven moving cars form the hearth of the furnace. They move through three heating zones which can be adjusted in temperature for the heating cycle desired. The final heating zone is capable of heating billets to a maximum of 2300 F. Equipped with 34 burners, the furnace can use either gas or oil. Oil is used as the standby fuel.

The cars are discharged by a manually-controlled discharging machine, similar to the automatic charging machine. When a car has been discharged, it is pulled onto an exit lift by a hydraulically-operated car separator, lowered to a level beneath the furnace, and returned by means of a dolly to the charging end of the furnace in 40 seconds. Once again, the car is moved onto a hydraulic lift, raised to the furnace level at the charging end, and the cycle is completed. The cycle of the automatic charging machine is controlled by the movement of the hearth, and by a manual adjustment of the machine which is set according to the billet size being treated and the desired space between billets.

Furnace car has raised skids for better heat circulation.

The hydraulic lifts and the car separator are operated by a 200-psi hydraulic system supplied by a 40-hp pump. Movement of cars through the furnace is achieved by means of a hydraulic under car puller cylinder which is operated by an 800 psi hydraulic system powered by a 15-hp pump.

The charging and discharging machines each have a 650-psi hydraulic system powered by 15-hp motors.

The distance between the charging door and the discharging door is 108 ft. Width of the hearth is 12 ft. Overall length of the furnace, including the lifts and vestibules at either end of the furnace, is 148 ft.

Last year, The Timken Roller Bearing Co. installed the first magnetic stirrer in this country on one of its electric furnaces. The introduction of the tunnel-type furnace in steelmaking, another Timken company first, will further reduce operating costs and increase production capacity.

PROPER TOOLS FOR BATTERY MAINTENANCE AND REPAIR

▲ USERS of storage batteries for fork-lift trucks, industrial tractors, powerized hand trucks and other battery-powered equipment can add substantially to battery life and improve battery performance by having the correct assortment of standard and special instruments, supplies and tools on hand in the battery maintenance and repair shop. See Figure 1.

First and foremost, service engineers of Gould-National Batteries, Inc., have found that the battery shop should have an accurate hydrometer. Hydrometer readings indicate the state of charge of the cells. Properly recorded hydrometer readings, taken over the life of the battery, will tell the condition of individual cells and give a warning of sulphation and other conditions, in time for corrective steps to be taken.

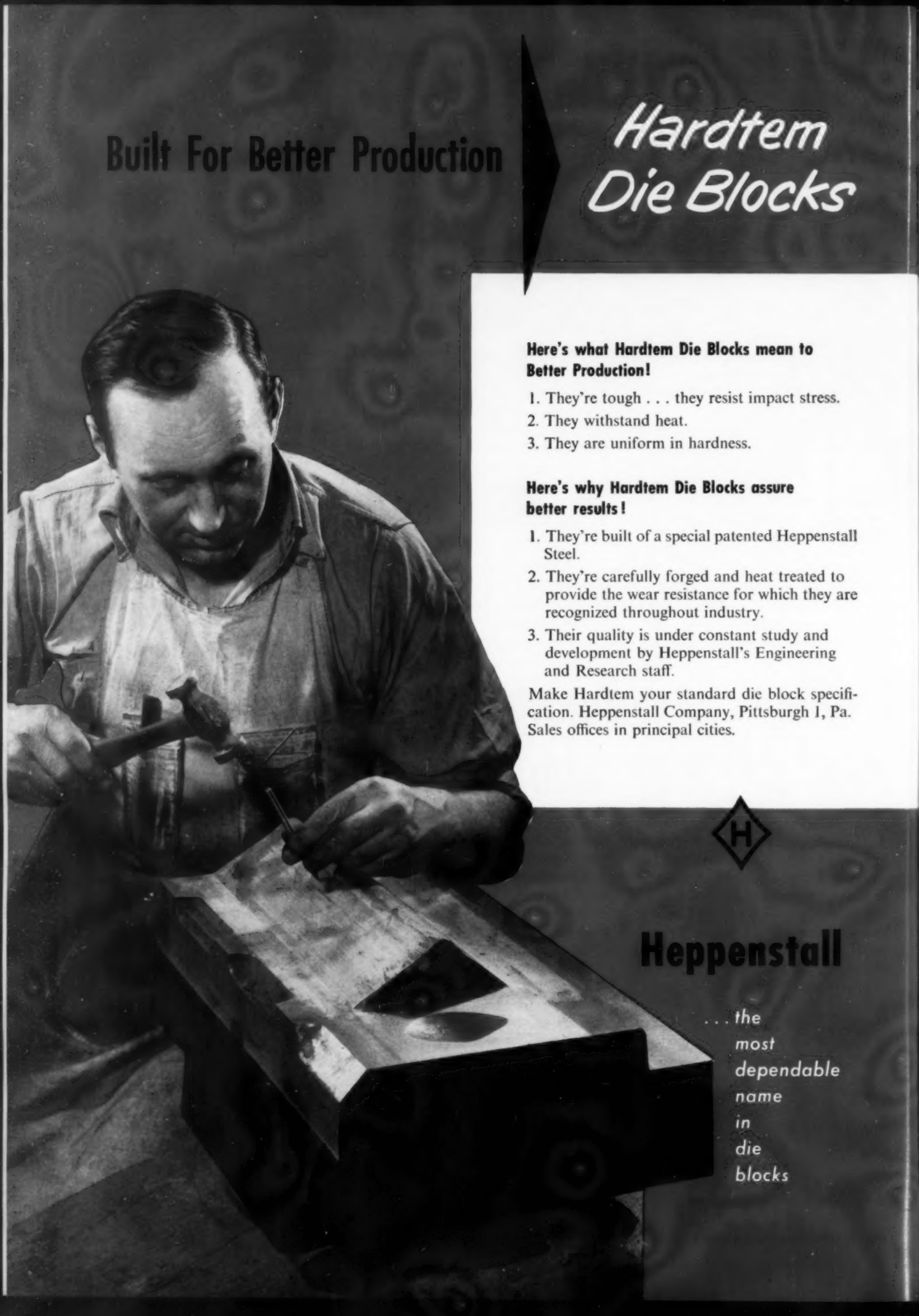
A thermometer is another "must." Specific gravity readings must be corrected to reflect temperature changes. A thermometer will also indicate undesirable temperature increases during charging.

A voltmeter is recommended for checking the voltage of the battery as a whole, and of individual cells, to detect malfunctions.

For long life, it is important to keep batteries clean. A well-equipped shop should, therefore, have wire brushes to remove corrosion and dirt from terminals, connectors and other parts. A sharp knife is useful for scraping off accumulated, encrusted corrosion. Rags or waste should be available for wiping up accidentally spilled water, acid or electrolyte. A quantity of mineral grease or vaseline should be on hand to coat terminals, etc., after cleaning. Soda should be among battery room supplies to neutralize spilled acid.

Even in relatively small battery shops, it is sometimes necessary to remove a damaged cell from a battery and replace it. For this job, a special drill is required to remove the intercell connectors from the damaged cell. This is shown in Figure 2. In some cases, a standard $^{15}/_{16}$-in. drill can be used, drilling $^{3}/_{8}$-in. into the post. On some batteries it is possible to use a metal saw to cut the connectors.

After the connectors are drilled or sawed and removed, a warm putty knife is needed to cut the sealing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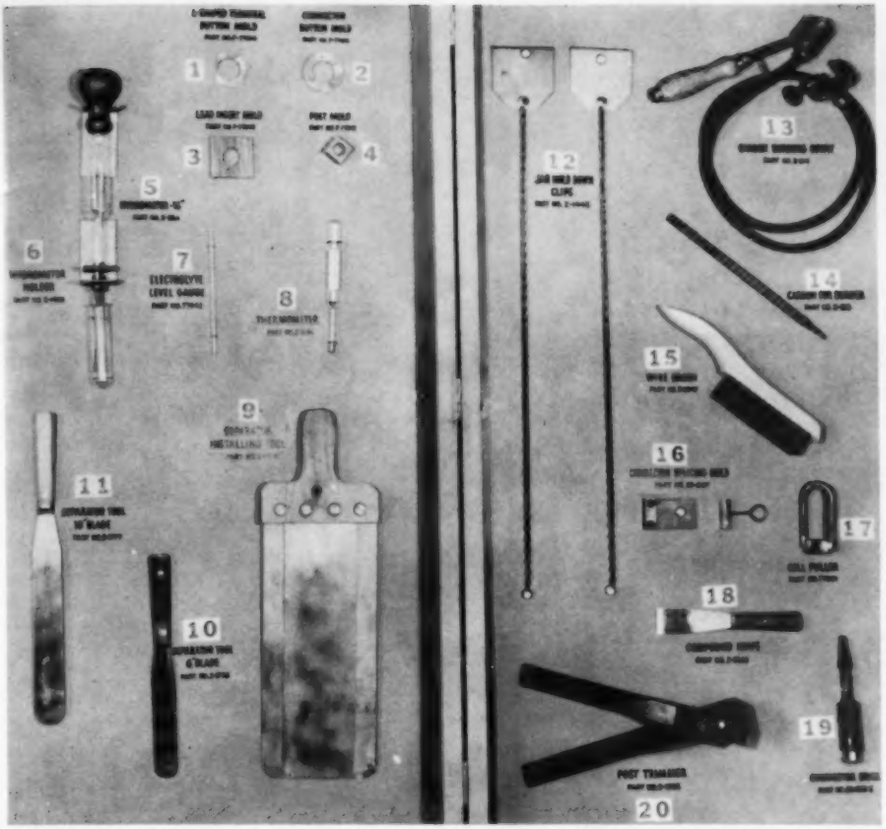


Figure 1 — Here is a complete set of suggested battery maintenance and repair tools.

compound between the damaged cell and adjacent cells.

When the cell is free to be lifted out of the tray, two special cell pullers should be attached to the negative posts of the cell, a wooden or non-metal piece placed through the loops of the cell puller, and a rope attached to pull up manually or with a power hoist (Figure 3).

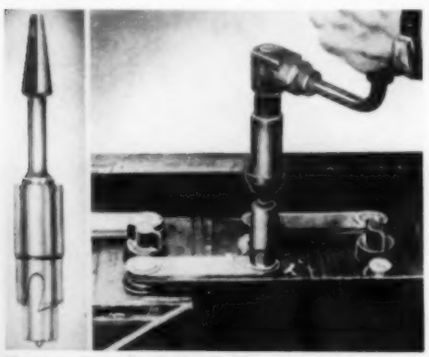


Figure 2 — Drilling an annular hole with the special tool shown at left. This tool permits cell connectors and jar covers to be removed without disturbing the terminal posts.

The same tools are required to replace the damaged cell. In addition, lead burning equipment is needed to restore the intercell connectors. This may be an acetylene or carbon arc burner (Figure 4). Several molds are needed for this job (Figure 5). The posts must be built up using a special mold (Figure 5 left). The posts must be burned or melted to form an integral part unit with the intercell connector. In cases where the connector has been cut by sawing, a special splicing mold should be used (Figure 5 center) as in Figure 6 to rejoin the intercell connectors.

Sealing compound and equipment for heating and pouring should be part of the battery room equipment. This is used to reseal the replacement cell in the battery.

Figure 3 — The new cell puller should be used to lift cells from the battery for repairs and examination.

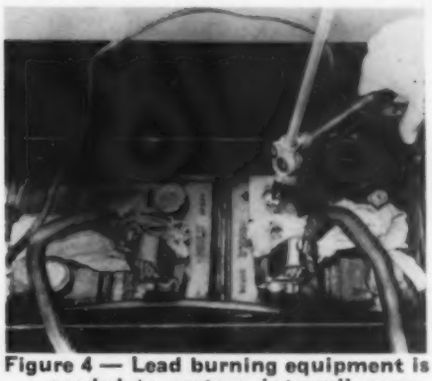


Figure 4 — Lead burning equipment is needed to restore intercell connectors and build up posts.

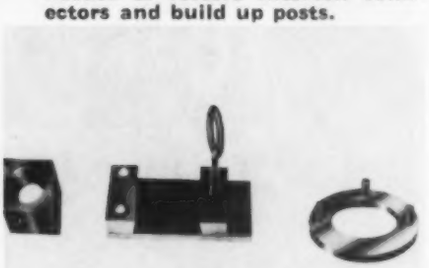


Figure 5 — Various molds such as these shown above are used with lead burning equipment to build up lead posts and connectors in reassembling a repaired cell into a battery.

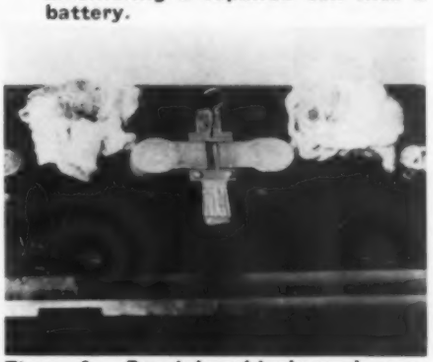


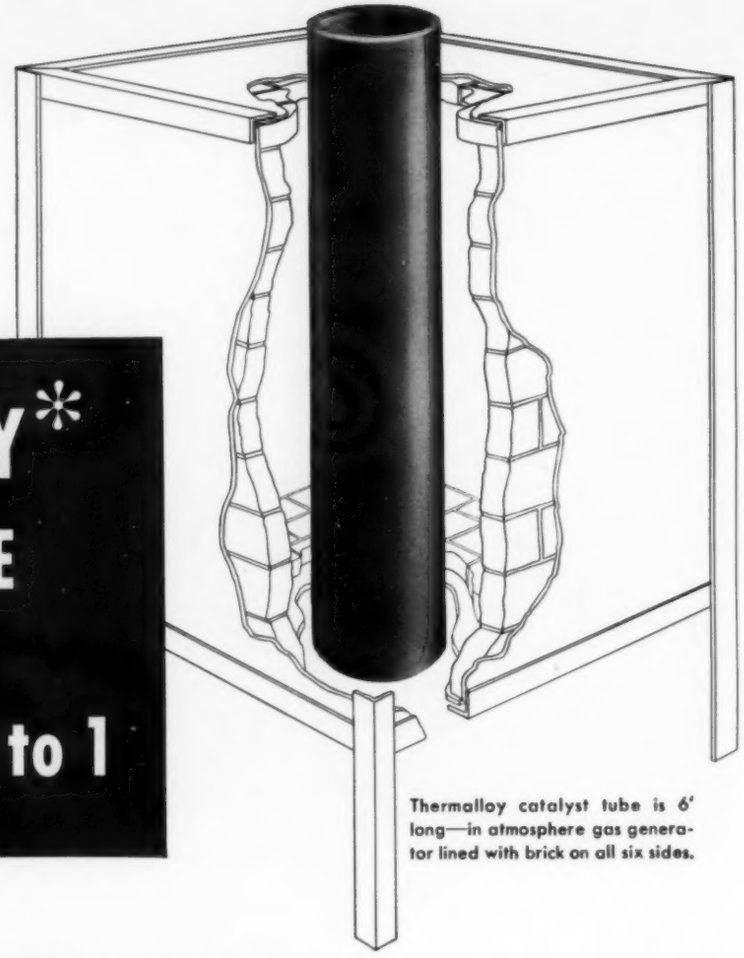
Figure 6 — Special mold, shown in center of Figure 5, is set to rejoin connector by lead burning.

Some larger battery shops are called upon to repair damaged batteries completely. Very little additional equipment is needed. Holding-down clips are useful to remove the element from a cell. A special L-shaped tool with lifting handle makes it easier to remove a cover.

A sturdy table with a wooden or non-metal top is useful in repairing cells and in the assembly of new separators.

A supply of battery grade sulphuric acid is advisable—especially when repaired cells must be refilled with electrolyte. Suitable mixing vessels and charts will prevent damage to personnel and batteries.

THERMALLOY* CATALYST TUBE outlasts refractory tube 9 to 1



Thermalloy catalyst tube is 6' long—in atmosphere gas generator lined with brick on all six sides.

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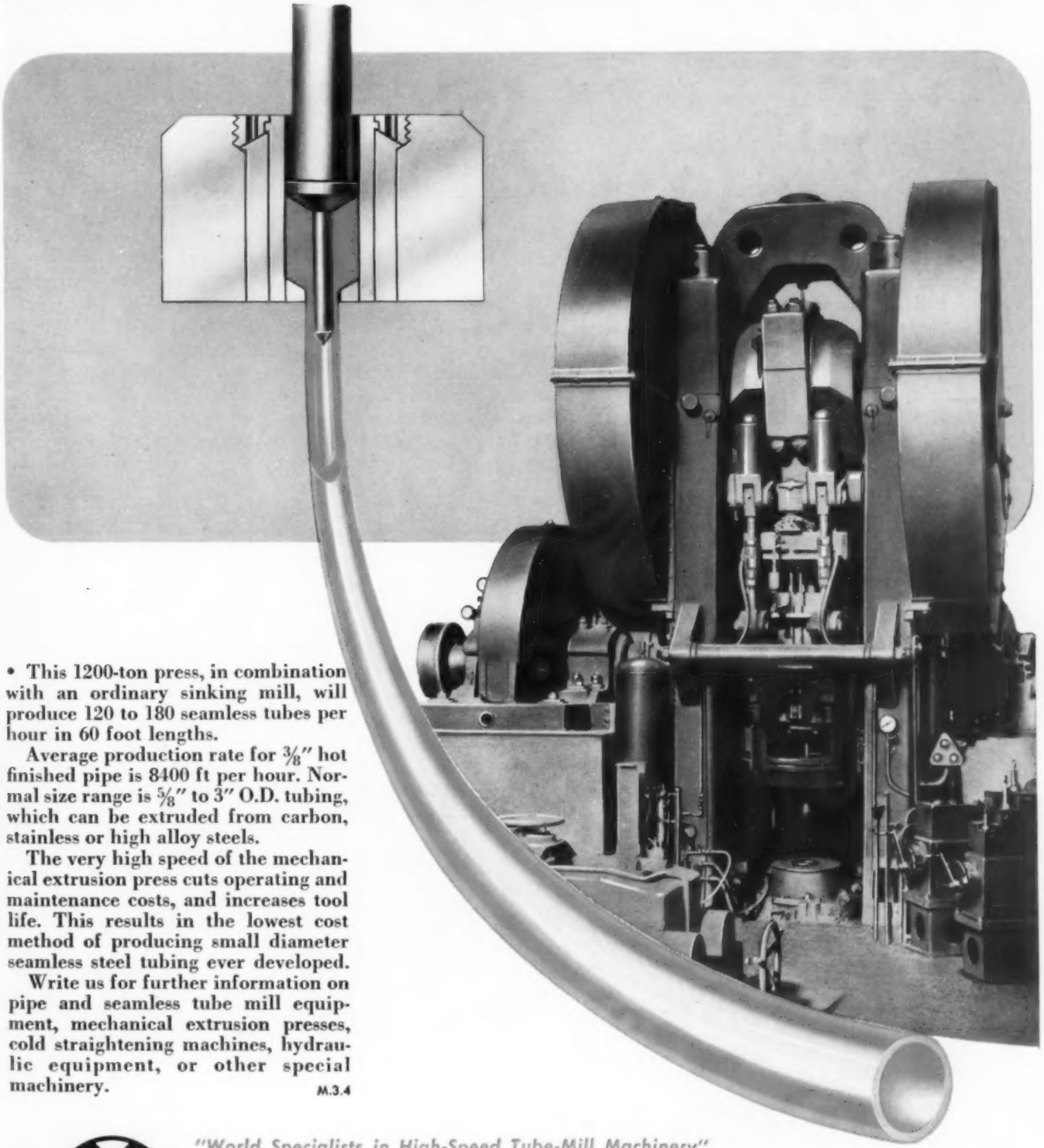

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HOW TRAILABILITY DETERMINES TRACTOR-TRAILER AISLE WIDTHS

By JOHN J. SICHMAN
Assistant Chief Engineer
Mercury Manufacturing Co.
Chicago, Ill.

▲ONE of the major factors determining the minimum aisle widths necessary for an in-plant tractor-trailer system is the ability of the train of trailers to approximate the initial path of the tractor. This trailability depends mainly upon the relative positions of the fixed wheels of the trailer and the articulate points of the couplers.

There are three basic types of industrial trailers. Each gets its name from the wheel suspension used to steer it, and each trails relatively effectively. The types are: the caster-wheel steer trailer, the fifth-wheel steer trailer, and the four-wheel steer trailer.

The caster-wheel steer trailer, developed from the caster-wheel hand truck, consists of a platform mounted on four wheels. Its front wheels are mounted in swivel caster assembly. Rear wheels are mounted on a fixed axle and are usually larger than the caster wheels. They carry the bulk of the load.

The caster-wheel trailer turns by swiveling on its front caster wheels and pivoting about a vertical axis whose location changes from a position midway between the fixed rear wheels, as when the trailer is turned by hand, to a position along the centerline of the fixed axle where it is coincident with the instantaneous center, as when it tracks or trails at the minimum turning radius of the train. See Figure 1 for the visual explanation.

Caster-wheel steer trailers are moved easily by hand and can be turned in very confined spaces. In addition, a train made up of these trailers will trail highly accurately. For all-purpose work, the caster-wheel trailer is probably superior to any other.

The second kind of trailer, the fifth-wheel steer type, generally has four equal-sized wheels. Its front steering wheels are attached to the platform by a wagon-type fifth wheel. These trailers steer in the same manner as a farm wagon or a dray wagon and are modifications of this type of vehicle. The fifth-wheel trailer is particularly well suited for heavy loads and the hardest of service.

However, a train of these trailers will not trail as accurately as a train of caster-wheel trailers and is not reversible. In addition, fifth-wheel steer trailers are hard to turn by hand in confined places. They are difficult to back up with a tractor because double pivot points are involved. A special application of the fifth-wheel steering mechanism to both ends of the trailer (double fifth-wheel) makes this type trailer reversible.

The third type of trailer, the four-

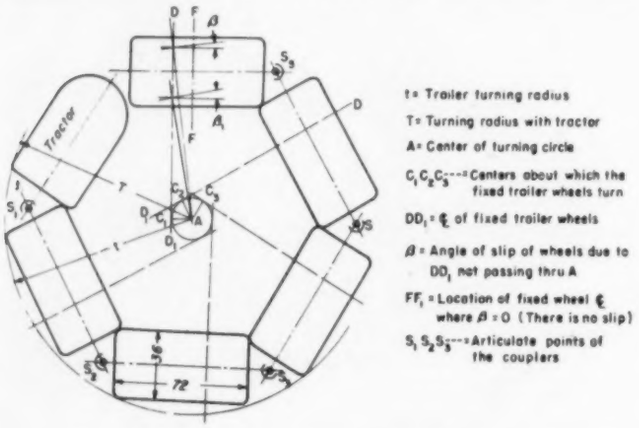
Tractor
72
t = Trailer turning radius
T = Turning radius with tractor
A = Center of turning circle
C1C2C3---= Centers about which the fixed trailer wheels turn
DD1 = ℄ of fixed trailer wheels
β = Angle of slip of wheels due to DD1 not passing thru A
FF1 = Location of fixed wheel ℄ where β = 0 (There is no slip)
S1S2S3---= Articulate points of the couplers

Figure 1 — The five caster-wheel steer trailers in this train turn by pivoting about instantaneous vertical axes whose centers are located at C_1, C_2, etc. If the fixed axles of these trailers were located at FF_1 rather than DD_1, the trailers would turn about a vertical axis through A.

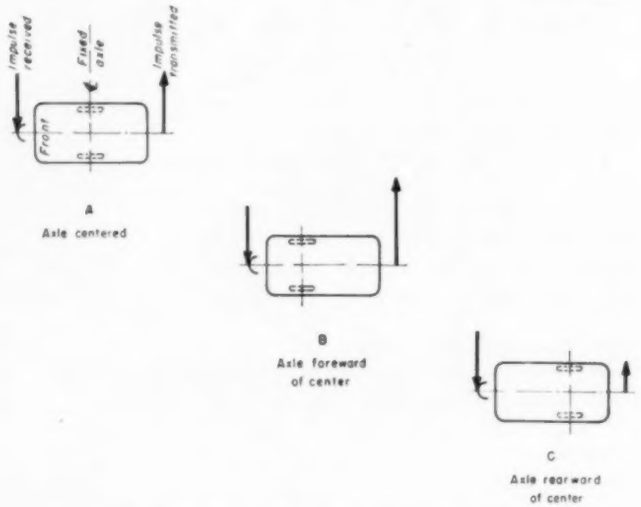

Figure 2 (right)— With the fixed axle at the center of the platform, as shown at A, any force transmitted by the tractor to the front coupler of the first trailer will be transmitted in equal magnitude by the rear coupler to the second trailer. With the fixed axle forward of center, as shown at B, the initial force from the tractor will be magnified as it is transmitted to the second trailer. However, with the fixed axle rearward of center, C, the initial force from the tractor will be diminished as it is transmitted to the next trailer.

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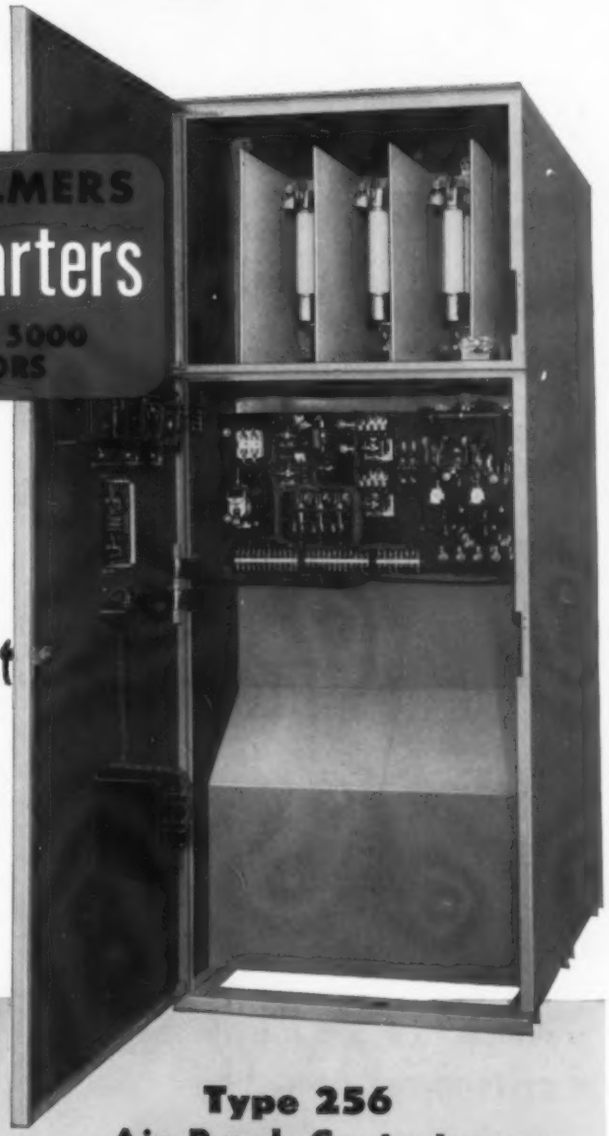

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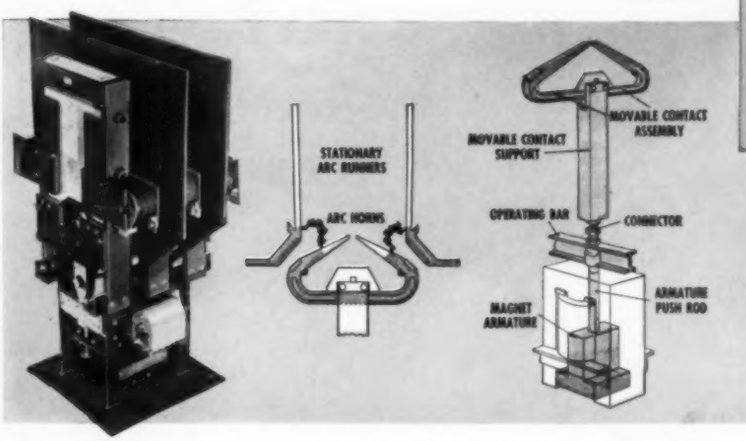

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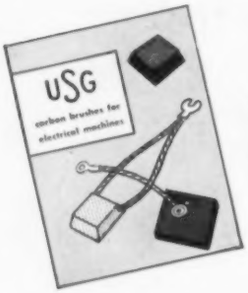

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wheel steer trailer, has all four wheels arranged to steer simultaneously. This type of trailer is often a further adaptation of a double fifth-wheel type, namely, two fifth-wheel steering assemblies connected by cross bars. In some designs four wheel steering is accomplished through use of knuckle mounted wheels.

Four-wheel steer trailers are excellent where accurate trailing is absolutely essential. However, they are extremely difficult to maneuver by hand and require considerable space in which to turn. For these reasons they are used rarely.

The relative positions of the fixed wheels and the articulate points of the couplers determine the ability of the trailer to approximate the initial path of the tractor.

If the positive or fixed wheels of a hypothetical trailer of this type are located midway between the articulate points of the couplers, the trailer will move in such a manner that every articulate point will follow the path of the turning arc and will always be equally distant from the theoretical vertical axis running through the middle of the fixed axle. In theory, a trailer constructed in this manner will trail perfectly. However, a trailer with its fixed axle in the middle is susceptible to whipping actions caused by the normal side motions of the tractor.

This tendency to whip is easily understood if we consider the trailer as a lever pivoted at its middle and taking alternate thrusts at its front end from the right and left, see A of Figure 2. It can be seen that any force transmitted by the tractor to the front coupler of the trailer will be transmitted in equal magnitude by the rear coupler to the next trailer. In other words, there is a one-to-one ratio between the two forces because their leverarm distance is equal.

Moving the fixed wheels forward, as shown in B, would tend to magnify the transmitted forces. For example, any side motion transmitted from the tractor to the front trailer coupler would be transmitted by the rear trailer coupler to the next trailer and magnified by the ratio of the rear lever distance to the front lever distance of the trailer. Therefore, the ideal solution—one that will inhibit rather than induce whipping—would be to move the fixed axle rearward, as shown in C, so that any transmitted side motion would be diminished rather than magnified.

Unfortunately, any gain in the trailer's ability to counteract whipping is accomplished at the expense of trailability. Because the centerline of the fixed axle no longer passes through the center point of the turning arc, the train made up of trailers whose fixed axles are located to the rear of the center of the platform will not follow the curve accurately.

These trailers cut in a trifle as they trail and have separate paths and separate pivot points. Thus, the turning path, formerly a circle now resembles a parabola, see Figure 3, and the pivot point is now an instantaneous center.

Naturally, with this constant trailing error or deviation, the extra aisle width needed for turning is further determined by the number of trailers in the train—the longer the train, the wider must be the aisle dimensions. A train of five to six trailers has been found to offer optium load-carrying capacities without requiring uneconomically large aisle widths.

Experience has shown that reasonably accurate trailing without whipping can be achieved if the fixed wheels are located approximately one-third of the deck length from the rear of the trailer. The location of the free-swiveling casters has no bearing whatsoever on the trailing of the vehicle and little or no effect on the whipping. However, their location does affect the gradability and stability of the trailer. If the king pins of the swivel casters are located approximately one-sixth of the deck length from the front of the trailer, gradability and stability will be good.

With the fixed and caster wheels in the positions indicated, the rear wheels will carry approximately two-thirds of the load while the caster wheels will carry the remaining one-third. This is one of the reasons why the caster wheels are smaller than the fixed wheels.

The one-third and one-sixth deck-length proportions are easily maintained on trailers up to 9 ft in length. However, for longer trailers, these proportions are necessarily deviated from to favor grade clearance and to avoid highly-concentrated frame stresses.

Figure 3 — As shown at A, a train of caster-wheel steer trailers trails perfectly (with a circular turning path) when the fixed axle of each trailer is located midway between the articulate points. However, the tendency for these trailers to whip is high. With the fixed axle located to the rear of center, as shown at B, each of the five caster-steer trailers in the train deviates slightly from the initial path of the tractor. This deviation causes the turning path to resemble a parabola and makes aisle-width dimensions larger. However, trailability is still good and the whipping tendency is almost eliminated.

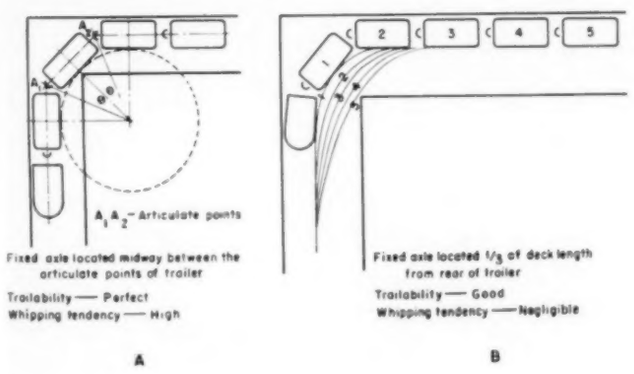
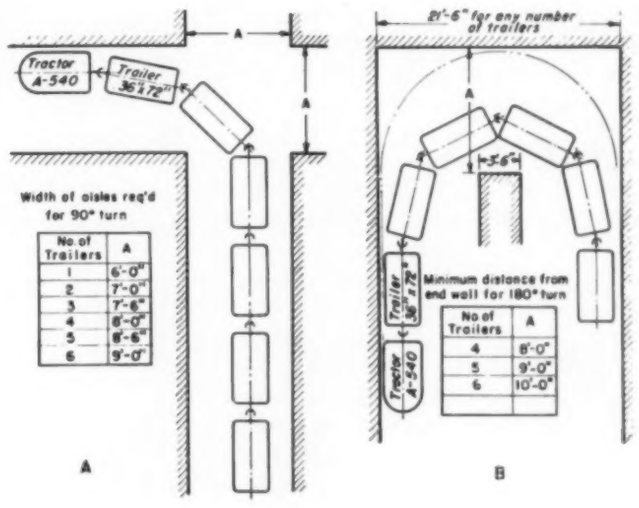


Figure 4 — Minimum aisle-width dimensions are governed by the sizes of the tractor and the trailers, the type of trailer wheel suspension, and the number of trailers in the train.



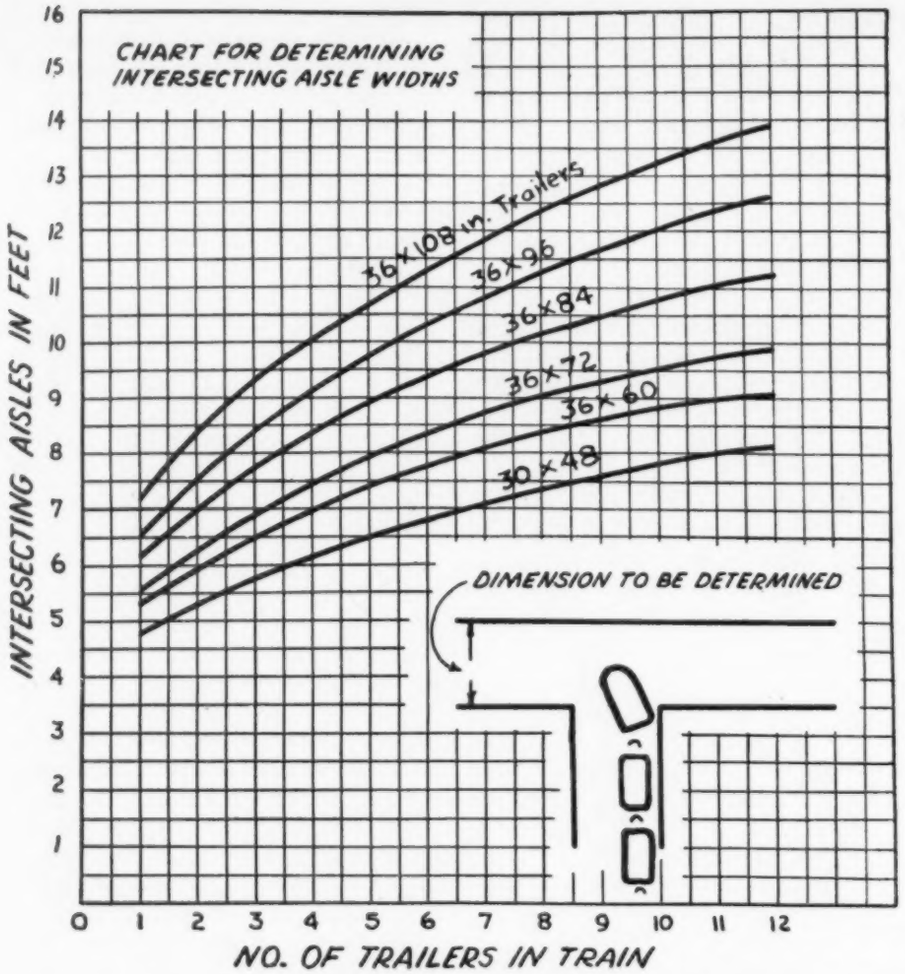


CHART FOR DETERMINING
INTERSECTING AISLE WIDTHS
INTERSECTING AISLES IN FEET
NO. OF TRAILERS IN TRAIN
36x108 in. Trailers
36x96
36x84
36x72
36x60
30x48
DIMENSION TO BE DETERMINED
0 1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Figure 5 — To ascertain minimum intersecting aisle sizes: (a) find the number of trailers in the train on the abscissa of the graph, (b) follow the vertical line upward to the curve of the correct trailer size, and (c) follow the horizontal line across to the ordinate of the graph where the values for intersecting aisle-widths are given in feet. To this value add approximately 1 ft for clearance.

end wall when making a U-shaped turn.

Beyond a certain number of trailers, aisle-width dimensions for all practical purposes remain the same. For example, the results of this test showed that an overall dimension of 21½ ft is sufficient for any number of trailers. The reason for this is that after a certain number of trailer turns, the maximum turning angle of the trailer couplers is reached and the remaining vehicles in the train—instead of following a constantly-deviating path—now follow a relatively fixed path.

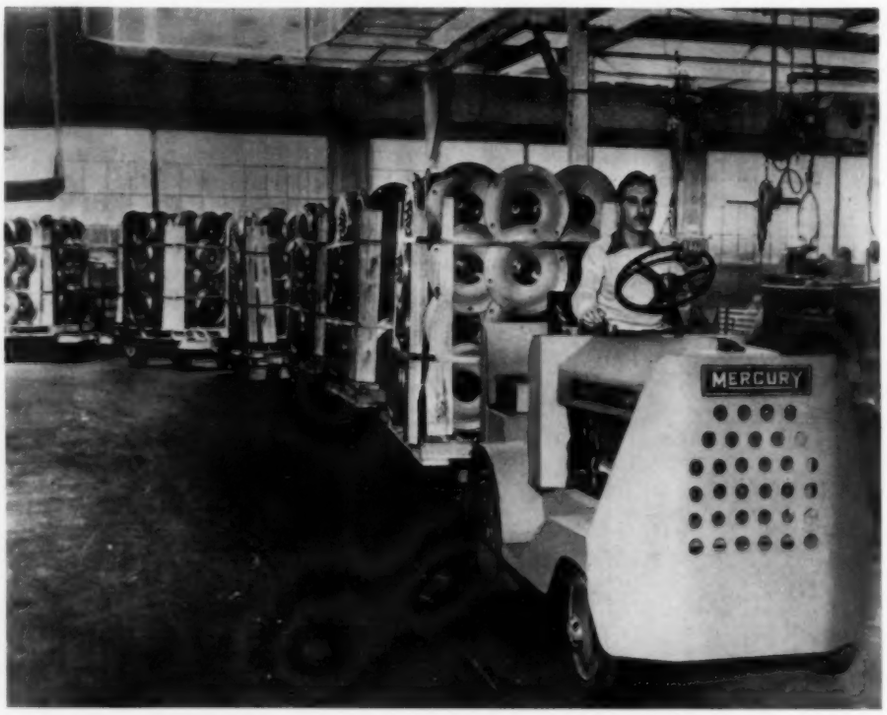
Curves compiled by manufacturers of tractor-trailer systems are useful in determining aisle-width dimensions when trailer sizes and wheels suspensions are known. The curves in Figure 5 give the recommended minimum intersecting aisle-width dimensions for trains of caster-wheel trailers, equipped with safety self-couplers, whose fixed axles are one-third of the deck length from the rear of each trailer.

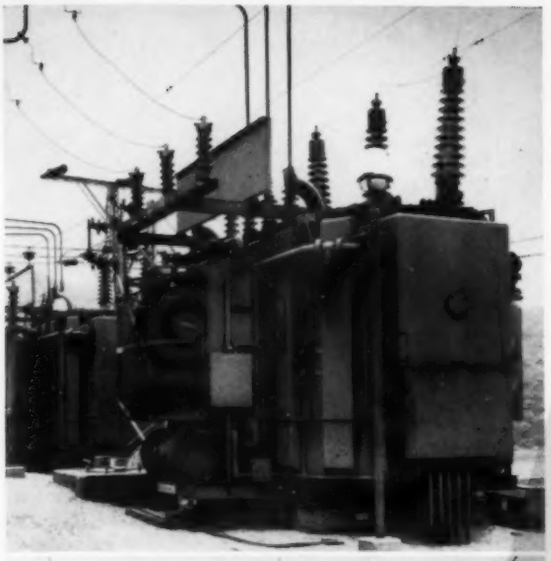
For example, a train of eight 36 x 96-in. trailers would require approximately 11½ ft aisle widths. Allowing for proper clearance for this train, we add 1 ft which makes the recommended dimension 12½ ft. To find aisles for trailer widths not shown, find intersecting aisles for trailers of same length and add or subtract the difference in width.

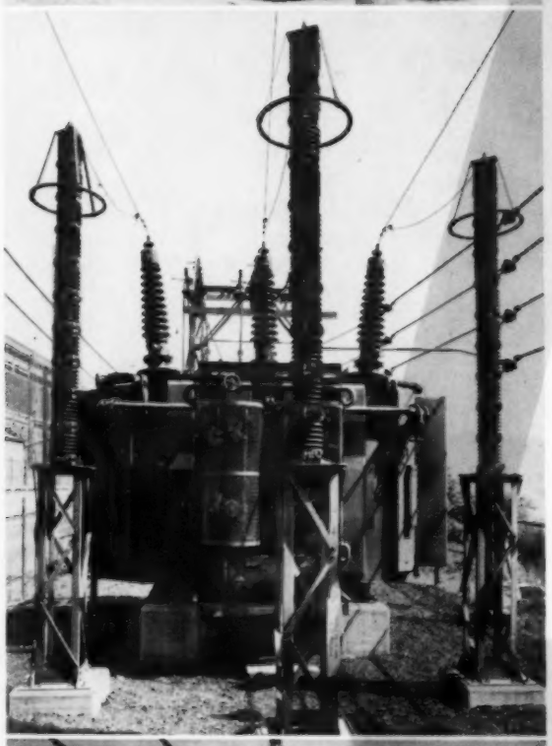
Because industrial trailers are designed to effect a compromise between trailability and whipping, their turning points—instantaneous centers with constantly-changing paths—are difficult to lay out on paper. Therefore, tests run on actual equipment, or scale models, offer the quickest, easiest and most accurate methods for determining tracking paths and aisle-width dimensions. Figure 4 tabulates and illustrates typical test results.

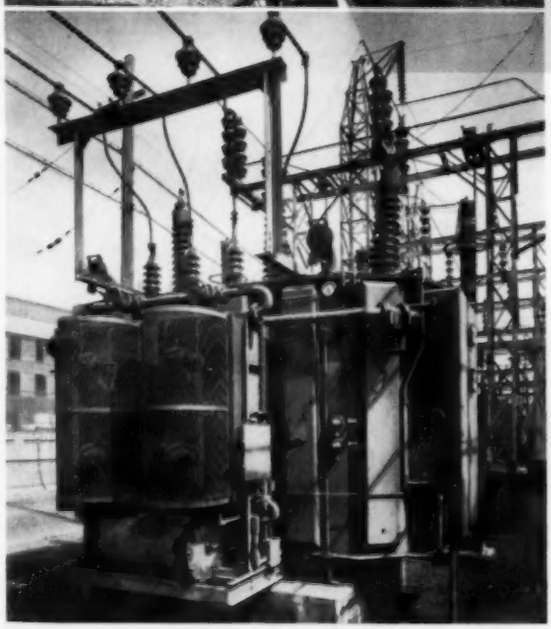
In this illustration, a 41 x 72-in. three-wheel, short-turning radius tractor is shown towing a train of six 36 x 72-in. caster-wheel trailers through 90 deg and 180 deg turns. Tabular values give: (A) the necessary aisle-width dimensions (with sufficient clearance) for trains from one to six trailers turning through a right-angle turn, and (B) the minimum distances that trains of four, five, and six trailers must be from the

Figure 6 — Tractors with trailers are economical for moving many items.









...Four 30,000 kva PENNSYLVANIA TRANSFORMERS

supply the power requirements of the Brackenridge plant of ALLEGHENY LUDLUM STEEL CORPORATION

Each of these transformers is rated at 30,000 Kva, 3 Phase, Oil-Immersed, Forced-Oil-Cooled. Together, the four transformers supply 120,000 Kva of power to the Brackenridge Plant. But as usual, there is more to the story than the rating of the transformers.

Here are four transformers that were designed to rigid height limitations so they could be delivered by trailer truck to their installation sites. The voltage — 132 Kv — called for intricate engineering and strict attention to mechanical detail.

The first unit to be installed at Brackenridge illustrates how carefully the design was worked out. The transformer was trucked over 44 miles of first and second class highway and rolled off the trailer onto its foundation — all in one day. To reach Brackenridge, each transformer had to be light enough to go over bridges, small enough to go under viaducts, and properly distributed in weight to negotiate sharp curves with safety.

For a better picture of how this was done, we invite you to write us on your letterhead to arrange for a showing of our 16mm. black and white movie entitled "30,000 Kva En Route."

Pennsylvania Transformer Company

A McGraw Electric Company Division • **Canonsburg, Pa.**

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CAR DUMPER

Rugged

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The record of rugged dependability and economical service established at Weirton is typical of Alliance performance everywhere. Building safer, stronger and better machinery is the Alliance aim. It is our goal to make the name Alliance synonomous with quality, dependability and service.

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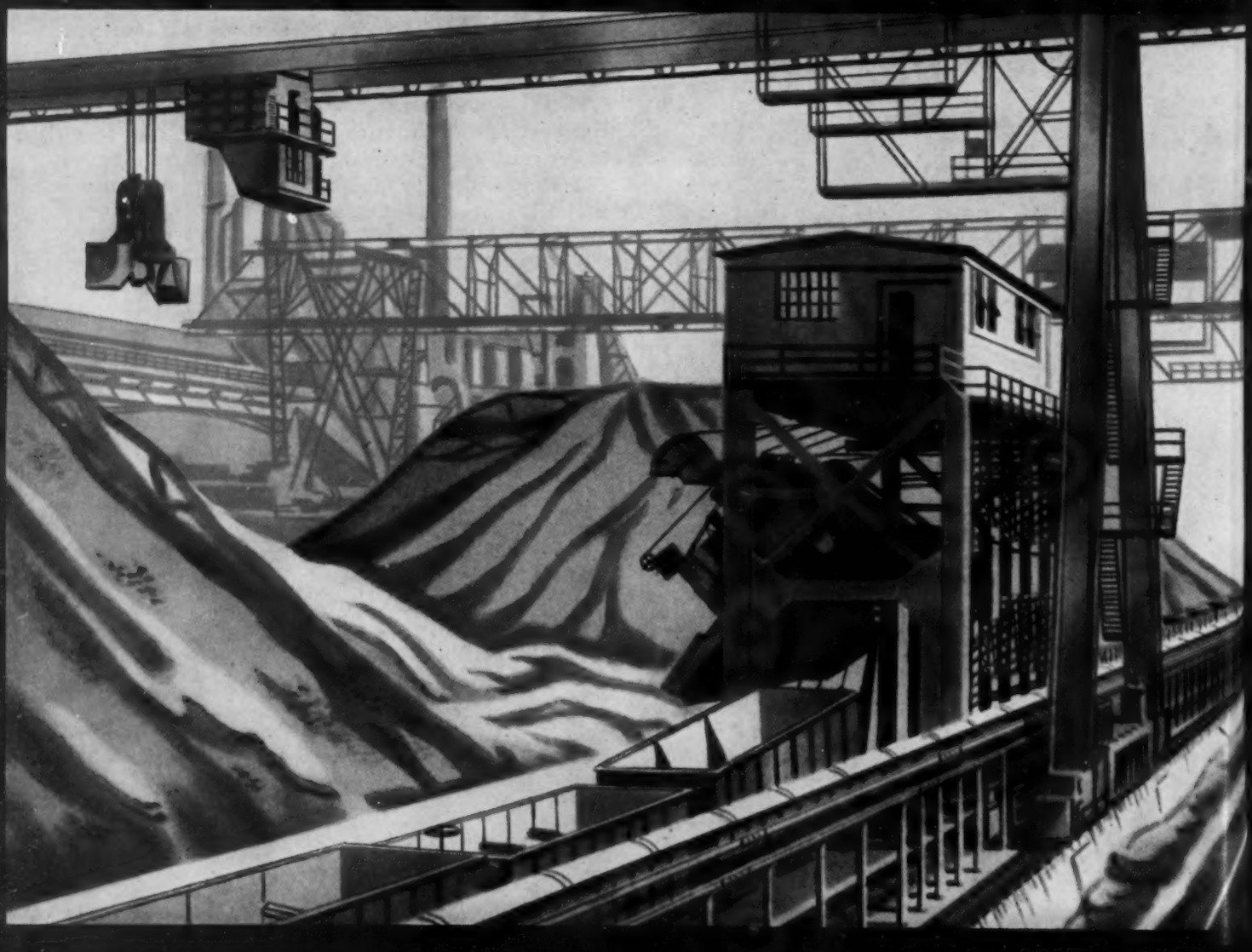

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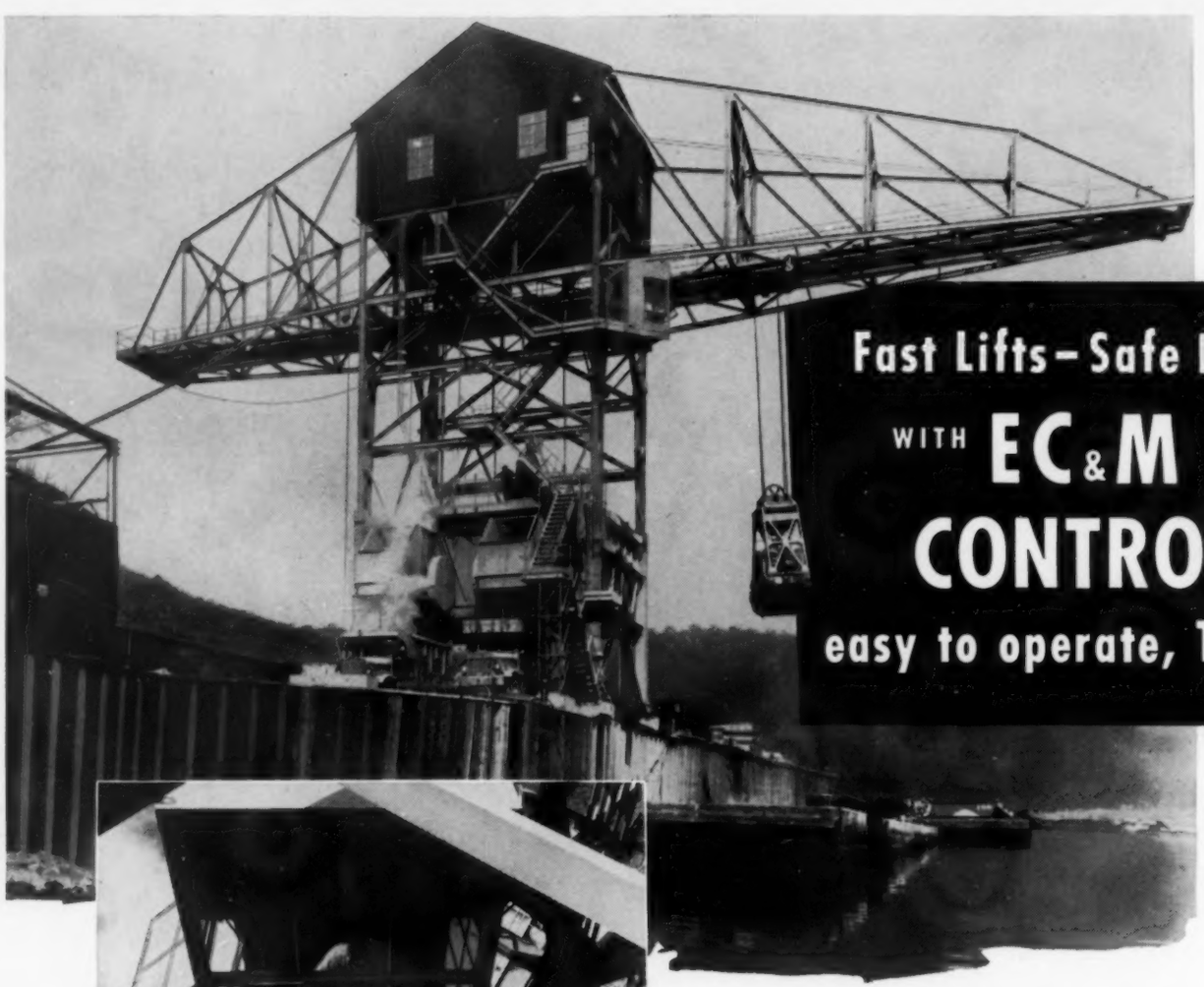
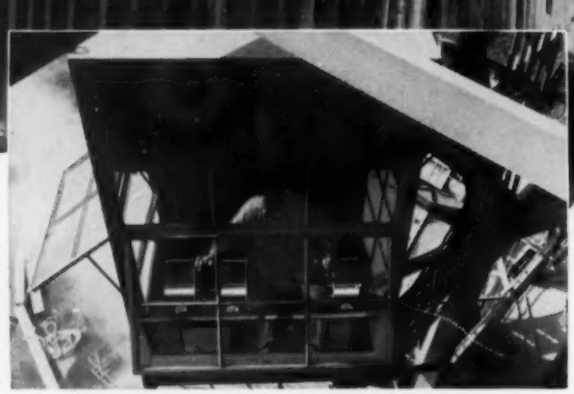
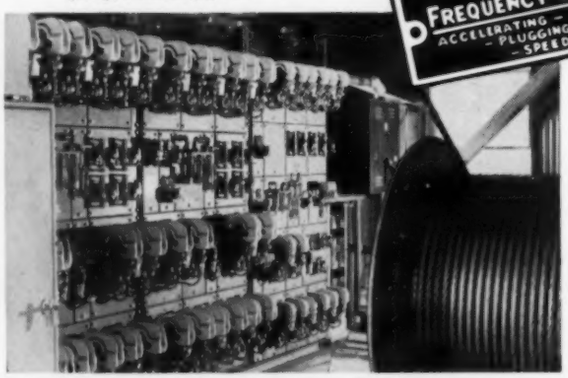


Fast Lifts – Safe Lifts WITH EC&M CONTROL easy to operate, TOO



Narrow-width EC&M Cam Master Switches are closely grouped for operator's convenience on this 720 ton-per-hour Barge Unloader, designed, fabricated and erected by Heyl & Patterson for the Duquesne Slag Company, Pittsburgh, Pa.



EC&M LINE-ARC Contactor Controllers for Closing & Holding Line Motors and for the Trolley Motion are EC&M Frequency Relay Controlled for fast, safe operation.

Output increases and costs go down when operators find rhythmic response at their finger-tips. Paying out cable to dig into the pile, taking the swing out of a loaded bucket at the point of discharge, and keeping the bucket open when lowering for another load are time-savers on bulk material-handling applications.

On river unloading stations, at lake and ocean ports, EC&M Control has a reputation among operating management for fast handling because bucket manipulation, trolley travel and similar operations respond quickly to the operator's needs. Straight-line, lever-operated EC&M Cam Master Switches have a short throw in both directions—are less tiring on the operator—the off-point is distinct and easy to find when returning from any of the speed-points. Put your control applications up to EC&M.

It pays to specify **EC&M Control—control engineered for high output with safety.**

THE ELECTRIC CONTROLLER & MFG. CO.
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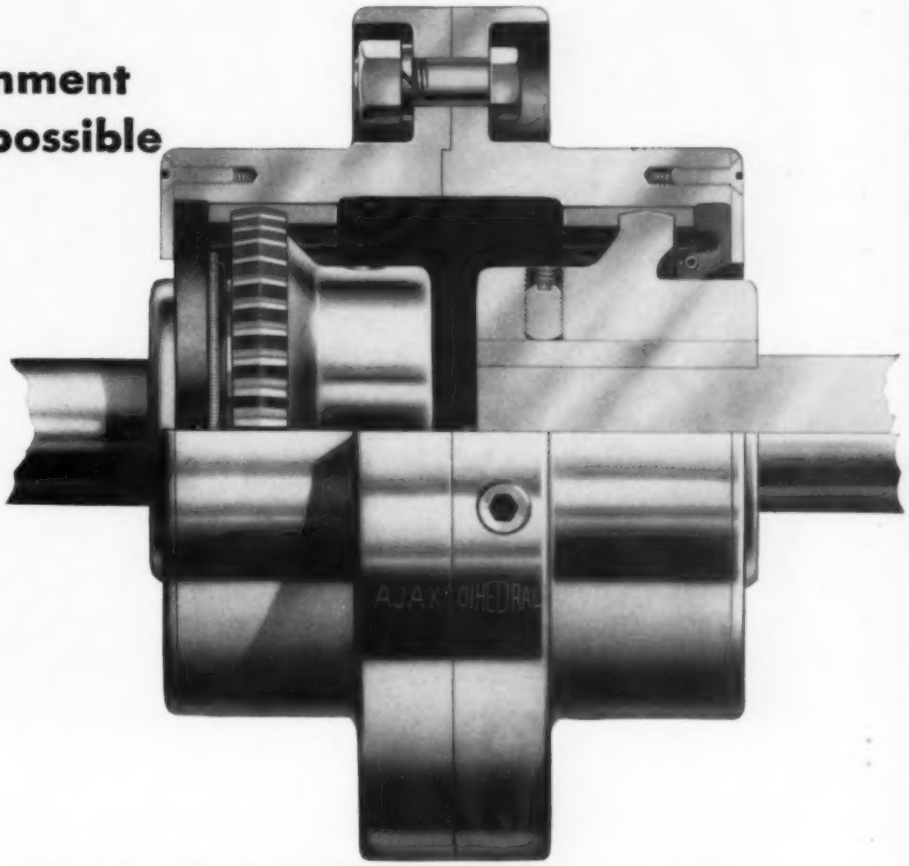
AJAX DIHEDRAL COUPLINGS

Protection against misalignment heretofore considered impossible



● The Ajax Dihedral Coupling is a radically new, different and efficient spline or gear-type coupling designed to handle shaft misalignment far beyond the capacity of conventional flexible couplings.

They simplify machine design, manufacturing, installation and maintenance by eliminating necessity for precision alignment of driving and driven shafts. Tooth clearance (backlash) is held to lubrication film requirements.

Angular Misalignment

Offset Misalignment

Offset and Angular Misalignment

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● More tooth area is in contact under misalignment than is possible with any other shape of tooth. Load is carried at center of teeth at the point of greatest strength. No end-of-tooth contact to resist free end-float. All teeth are case hardened by induction combining hard wear surface with tough core. Positive seals keep lubrication in and dirt out.

Made in standard, mill motor and floating shaft types. Table gives basic sizes and capacities. Write for catalogs.

Coupling Size	Maximum Bore	Mandrel Bore	Capacity H.P. @ 100 R.P.M.	Maximum R.P.M.
150	1⅜	¾	12	12,000
200	2⅛	1	24	9,300
250	2⅝	1	48	7,900
300	3⅛	1½	77	6,800
350	3⅝	2	130	6,000
400	4	2	190	5,260
450	4½	2½	260	4,770
500	5	2½	350	4,300
550	5¾	2½	440	3,900
600	6½	3½	605	3,690
700	7¾	3½	965	3,220

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For the services of a Cities Service Lubrication Engineer... Write Cities Service Oil Company, Sixty Wall Tower, New York City 5, New York.

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"Cities Service Chillo Cutting Oil Has Proved To Be The Difference Between Ordinary And Quality Production In Our Shop!"

Here's Atlantic Automatic's story in their own words: "One of our tougher jobs recently was machining SAE 446 Stainless Steel with two forming, one threading and three drilling operations. The critical operation was drilling a .025 inch diameter hole, ⅛ inch deep. The drill would soon pack with chips and break. When a Cities Service Lubrication Engineer was called in, he recommended our using Chillo 44.

"This light-colored oil did the trick. DOWN TIME WAS CUT IN HALF AND DRILL LIFE INCREASED OVER 200%!

"We use Cities Service Chillo 44 to machine all types of metals covering a range of machinability from brass to stainless on our Brown and Sharpe 00G, 0G and 2G Automatics. It has proved to be the difference between ordinary and quality production in our shop!"

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TIN PLATE *giving* LONGER SHELF LIFE

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from these leased Oxygen Generators

Air Products **Generators shown at leading steel company produce low-cost oxygen . . . simultaneously produce high-purity nitrogen. Annealing gas made from this nitrogen is used to produce tin plate with superior surface characteristics.**

Make better tin plate—at low cost. Produce brighter steel strip . . . improve pickle-lag time. Lease an *Air Products* Generator to produce low-cost oxygen . . . use the high-purity nitrogen by-product for annealing. It's the most economical way to obtain annealing gas of this quality, and capital investment is lower than required for conventional methods. Let us give you full details!

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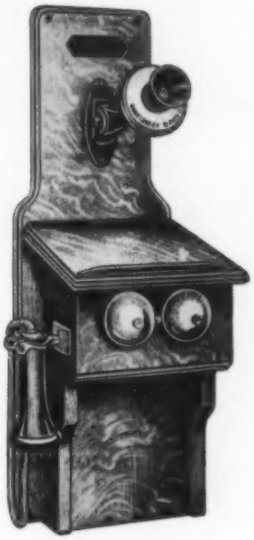
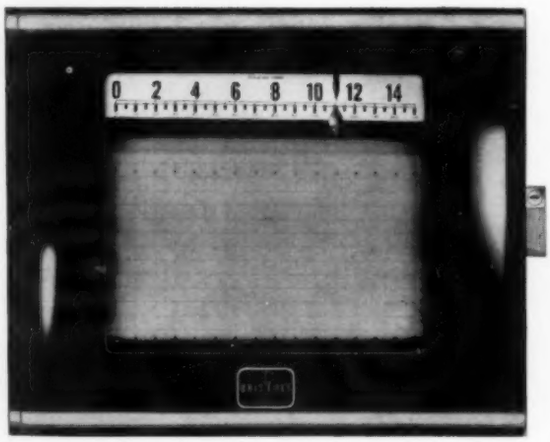
WHAT'S NEW AT BRISTOL . . . . WHAT'S NEW AT BRISTOL

Bristol makes DRY CELLS in potentiometers as obsolete as the wall telephone!



NEW *Bristol electronic Dynamaster potentiometers and pyrometers give you No-Batt CONTINUOUS STANDARDIZATION without dry cells*



The wall telephone has long since joined the parade to the past.

Now Bristol's development of No-Batt continuous standardization has put dry cells for instrument work in the same category.

Here's what the new Bristol instruments offer:

- **CONTINUOUS STANDARDIZATION** – which eliminates need for dry cells – supplies voltage that is continuously compared with standard cell.
- **CONTINUOUS OPERATION – NO TIME OUT.** With continuous standardization, the potentiometer is free to continuously measure, record, and control. No time out or interruption is required for periodic standardization.
- **NO STANDARDIZING MECHANISM.** Continuous standardization is taken care of electrically. The absence of standardizing mechanism simplifies the instrument considerably.

For the complete story on the modern Bristol Dynamaster, write for free 35-page booklet P1245. The Bristol Company, 123 Bristol Road, Waterbury 20, Conn.

LOOK FOR OUTSTANDING NEW DEVELOPMENTS FROM BRISTOL

BRISTOL

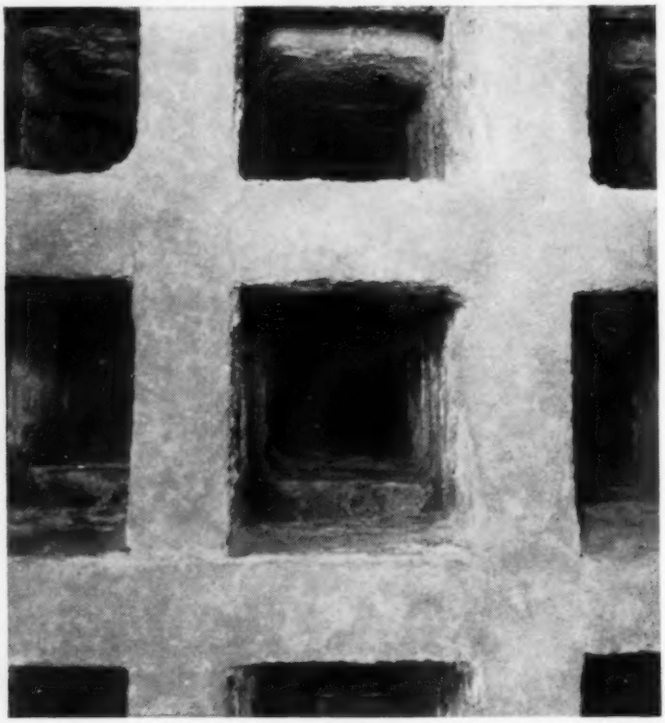
THE DEPENDABLE GUIDEPOST OF INDUSTRY

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

FOUR OPEN HEARTH CHECKER CHAMBERS CLEANED IN 10½ HOURS

Expensive rebricking job avoided; deposits removed from checkerworks by DOWELL engineers using a high-pressure solvent jet

Before chemical cleaning



After chemical cleaning

Recently, Dowell was called to clean four badly fouled checkerwork chambers of an open hearth furnace. A high-pressure solvent jet, designed by Dowell to combine chemical and hydraulic action, made it possible to complete the job in only 10½ hours!

Inspection after cleaning showed the checkerworks to be free of deposits. This cleaning by Dowell Service avoided an expensive rebricking of the checker chambers which would have required a maintenance shut-down of four or five weeks.

This was the fourth time these checkerwork chambers had been cleaned by Dowell—and the fourth time that the operator had been well pleased with the results.

The high-pressure jet is used by Dowell engineers to spray the lateral openings between the bricks, in effect actually scrubbing the refractory surfaces with chemical solvents. The size and shape of the checkerworks seem to have no bearing on the effectiveness of the jet.

Dowell engineers have had extensive experience in cleaning industrial equipment with chemical solvents. Almost every piece of equipment found in blast furnace gas cycles and open hearth furnaces has been cleaned by Dowell. As a matter of fact, some have been cleaned while in actual operation.

Call a Dowell engineer to discuss your maintenance cleaning problems. He'll be glad to make a cost estimate on cleaning your equipment with chemicals. If you prefer, write directly to Tulsa, Dept. B-29.

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Over 100 Offices to Serve You with Chemical Cleaning for:

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Chemical Services for Oil, Gas and Water Wells

DOWELL INCORPORATED • TULSA 1, OKLAHOMA

DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY

Date-line Diary...

January 4

▲ The AISI reports operating rate of the steel industry for the week starting January 4 is scheduled at 75.0 per cent of capacity. Index of production for week will be 111.3. This is equivalent to 1,788,000 tons as compared with 1,706,000 tons one week ago and 2,213,000 tons one year ago.

▲ Effective January 1, two major tax reductions took place; a 10 per cent reduction in individual income tax, and the excess profits levy was lifted from corporations. Social security tax was boosted from 1½ to 2 per cent. These are the first major tax cuts in five years.

▲ Producers expect steel production will be cut 10 to 15 per cent in 1954 to a total of 95,000,000 to 100,000,000 tons. Capacity increased 6,782,940 tons to 124,330,410 net tons as of January 1.

January 5

▲ The year 1953 was second top year in output of cars and trucks combined, according to Automotive News, with an output of 6,140,123 cars and 1,209,568 trucks and buses.

▲ According to the SEC, working capital of United States corporations rose to a record figure of $88,500,000,000 on September 30. This was a $600,000,000 increase during the third quarter and $3,100,000,000 above the total a year earlier.

▲ Allegheny Ludlum Steel Corp. effected a price increase ranging from $3 to $18 a ton on various regular grades of silicon sheets and coils.

January 6

▲ In Pittsburgh, No. 1 heavy melting scrap dipped $2 a ton to $31, the lowest selling price in the last four years.

▲ The Commerce Dept. estimated the rising unemployment total in December at 1,850,000. This is 400,000 higher than the previous month and 425,000 above December 1952.

▲ Kaiser Steel Corp., passed the million-ton production mark for the first time in 1953 with a total output of 1,064,668 net tons finished steel products. This was a 10 per cent boost over the previous year.

▲ The United States sent a $25,500,000 economic aid to India to be used for importing steel needed in railway, agricultural and other development projects.

January 7

▲ In the first half of the 1953-54 fiscal year, government spending has exceeded revenues by $9,100,000,000. This deficit is $200,000,000 less than the deficit in the first half of the preceding fiscal year.

▲ At the end of 1953, public debt reached $275,200,000,000 which was $7,800,000,000 higher than 1952.

▲ Appalachian Coals, Inc., southern marketing agency, forsees a decline of about 10,000,000 tons in bituminous coal production in 1954, to 441,500,000 tons. A big coal company estimates that output will decline to around 415,000,000 tons.

▲ The Bureau of Mines predicts 1954 United States metal consumption as follows in net tons: Refined copper, 1,350,000; lead 1,150,000; zinc, exclusive of scrap, 937,000; aluminum, 1,750,000; primary nickel, 105,000; tin, 85,000; sponge titanium, 3500; cobalt, 5400; primary magnesium, 38,000; molybdenum, 14,100; chromite, 1,200,000; tungsten, 3700; and primary antimony, 12,000.

January 8

▲ Eisenhower said that the 1954-55 budget for government spending will drop to less than $67,000,000,000 which is a $5,000,000,000 cut from the previous year's figure.

▲ The Commerce Dept. reported personal income at an annual rate of $285,500,000,000 in November, down nearly $2,000,000,000 from October.

January 9

▲ According to Eastern Railroad Presidents Conference, eastern railroads have agreed on rate reductions of from 18 to 20 per cent on many iron and steel products and will file the new tariffs with the Interstate Commerce Commission around February 1.

January 11

▲ The AISI reports operating rate of the steel industry for the week starting January 11 is scheduled at 75.0 per cent of capacity. This is equivalent to 1,788,000 tons as compared with 1,798,000 tons one week ago, and 2,238,000 tons one year ago. Index of production for week is 111.3.

▲ Public and private construction outlays in 1953 hiked to a record $34,000,000,000, 7 per cent above 1952.

January 12

▲ Russia is to begin delivery this month of pig iron to Britain's steel industry.

▲ According to the Commerce Dept., December retail sales in the United States amounted to $16,600,000,000, 1 per cent below November and 2 per cent below December 1952.

▲ Government figures showed manufacturers' profits after taxes in the September quarter were 5 per cent less than the preceding quarter or $2,900,000,000.

▲ The ARCI reports deliveries of new domestic freight cars in December totaled 4456 compared with 6137 in November and 7845 in December 1952. Orders in December totaled 2159 leaving a backlog of cars on order as of January 1, 1954, of 29,950 as compared with 80,296 on January 1, 1953.

▲ The Aluminum Association announced production of primary aluminum in November at 211,273,802 lb as compared with 216,438,214 lb in October and 149,277,906 lb in November 1952.

▲ In an effort to acquire an additional 21,000,000 lb a year of nickel the United States Government approved a $43,000,000 expansion project at its Nicaro nickel plant in Cuba.

January 13

▲ The Pennsylvania Railroad reached an agreement with the CIO United Railroad Workers of America to grant a five-cent hourly wage increase to about 36,000 shop employees.

▲ AISI announced that steel production in 1953 totaled 111,600,445 tons or 94.9 per cent of capacity, of this 3,855,892 tons were bessemer, 7,270,623 tons were electric, and 100,473,930 tons were open hearth.

▲ An announcement of the British Iron and Steel Federation stated Britain's steel mills produced a record 19,722,000 net tons last year, an increase of 9 per cent above 1952. Pig iron output was 12,516,000 tons.

January 15

▲ The Commerce Dept. has relaxed its controls on exports of a wide range of commodities. The strategic items it included are magnesium metal and molybdenum.

▲ Hudson Motor Car Co. and Nash-Kelvinator Corp. will combine under the name of American Motors Co. This new concern will rank fourth in its industry.

▲ Lukens Steel Co. reported a net income of $3,607,713 for 1953 after provision for income taxes. Sales for 1953 totaled $97,850,937, compared to $69,616,318 in 1952.

▲ American Can Co. agreed to grant an 8½¢ general wage increase to striking CIO steelworkers.

January 18

▲ According to the AISI, the average hourly pay to wage earners in the iron and steel industry in November was $2.323. A total of 667,400 workers averaged 38 hours a week. Total November payroll was $268,523,000. Total payroll for the first 11 months in 1953 reached $3,089,504,000 which exceeded any previous full year's total.

▲ The AISI reports operating rate of the steel industry for the week starting January 18 is scheduled at 74.3 per cent of capacity. This is equivalent to 1,772,000 tons, the same as one week ago and with 2,248,000 tons one year ago. Index of production is 110.3.

January 19

▲ Zinc, lead, and scrap copper prices each dipped ½¢.

▲ In order to meet demands of an expanding market, General Motors will spend $1,000,000,000 in the next two years for new production facilities.

January 20

▲ The U. S. Government will continue its controls on exports of iron and steel scrap during the first quarter of 1954. Russia and Red China will be excluded from any shipments.

▲ The first cargo of iron ore from U. S. Steel Corp.'s Cerro Bolivar mine reached Morrisville today.

January 21

▲ Sales and revenues of Republic Steel Corp. topped $1,000,000,000 in 1953 for the company's highest. Production of steel ingots also set a record at 9,630,454 tons which was almost 2,000,000 tons above that produced in 1952. Net income totaled $56,743,547 or $9.25 a share compared with $7.21 in 1952.

▲ According to the Bureau of Labor Statistics, housing projects totaled 1,102,400 units in 1953 as compared with 1,127,000 in 1952.

▲ The F. W. Dodge Corp. reported a new high dollar-volume record was established in 1953 with $17,443,463,000 in construction contract awards for the 37 states east of the Rockies.

January 22

▲ Kaiser Steel Corp. announced net earnings for the last six months of 1953 to be $3,835,619 on sales of $70,044,004 as compared with $3,623,657 for the same period one year ago. This is equivalent to 84¢ per share on common stock as compared with 77¢ one year ago.

▲ Iron and Steel companies in the United States expect to invest approximately $775,000,000 this year to expand and improve their plants, according to the AISI.

January 23

▲ Copper output will be reduced by Kennecot following a decline in consumption in December to 83,652 tons, the lowest since July 1952.

▲ Shareholders of American Metal Products Co., Detroit, Mich. and the Tube Reducing Corp., Wallington, N. J. approved a merger of both companies.

▲ The Youngstown Sheet and Tube Co. reported net earnings of $30,839,716 or $9.21 a share in 1953 as compared with $22,915,822 or $6.84 a share in 1952. Total income in 1953 totaled $554,059,088.

January 25

▲ The AISI reports operating rate of the steel industry for the week starting January 25 is scheduled at 73.8 per cent of capacity. This is equivalent to 1,760,000 tons as compared with 1,766,000 tons one week ago, and 2,240,000 tons one year ago. Index of production is 109.6.

January 26

▲ United States Steel Corp. announced income for the fourth quarter of 1953 at $56,012,628. Income for the year 1953 is reported at $222,735,656, or a return of 5.8 per cent on sales, and $7.56 a share compared with $4.54 a share in 1952.

▲ A dividend of 50¢ a share on common stock and $1.25 a share on preferred stock was declared by Jones and Laughlin Steel Corp. Net income for the year was $31,015,000 or $4.77 a share on common stock compared with $19,482,000 or $2.91 a share in 1952. Revenues in 1953 totaled $624,387,000.

▲ The FTC filed charges against Luria Brothers & Co., Inc. largest buyer and seller of scrap in the country, for monopolistic agreements with steel mills that they act as exclusive iron and steel scrap brokers.

▲ In England, private owners do not seem enthused about the government's latest offer of steel stock. The public bought only 500,000 of the 4,500,000 shares offered of Lancashire Steel Corp.

▲ The AISC announced 1953 shipments of fabricated structural steel were the highest since the record year of 1929. Shipments totaled 3,117,711 tons in 1953 compared with 2,664,255 tons shipped in 1952. Orders in 1953 totaled 2,786,591 leaving a backlog on December 31 of 1,740,998 tons.

January 27

▲ United States Steel Corp. anticipates an operating rate of about 80 per cent for the first half of 1953, according to Benjamin F. Fairless.

▲ To cut transportation costs, United States Steel has started using a combined rail-river route from its mines in the South to its mills at Gary, Ind. and South Chicago.

▲ Inland Steel Co. reported net income of $33,867,184 or $6.90 a share for 1953, a big recovery from the 1952 earnings of $23,755,218 or $4.85 a share. Total revenues in 1953 were $579,509,058.

January 28

▲ Wheeling Steel Corp. showed net sales of $217,356,078 for 1953, a sharp increase over the $178,274,292 net sales in 1952. Net profit totaled $12,458,311 or $7.49 a share compared with $6.43 in 1952.

January 29

▲ Bethlehem Steel Corp. declared an unexpected $2 dividend of $2 a common share for the first quarter of 1954. It had been paying $1 each quarter since early 1951. Net income in 1953 totaled $133,947,837 or $13.30 a share compared with $90,900,771 or $8.80 a share in 1952. For all of 1953, total sales were 2,082,025,788.

▲ Youngstown Sheet & Tube Co. will reduce output 1600 to 1800 tons daily and will temporarily furlough 800 to 900 workers for about three weeks while the blooming mill at the Brier Hill works is rebuilt.

January 31

▲ National Steel Corp. reports earnings for the year ending December 31, 1953 of $50,334,130, or $6.84 per share as compared with net earnings of $37,559,477 or $5.10 per share in 1952. Total income was $151,742,868.

▲ Consumer credit rose to a new high in December of $28,800,000,000 up $3,000,000,000 from the end of 1952.

Sixty-ton Bedford Crane with air-conditioned cab in the new melt shop of The Timken Roller Bearing Co., Canton, Ohio. Working directly over the severe flash heat of top charging electric furnaces, it positions and dumps approximately 40 tons of scrap per swing.

Bedford Cranes are backed by 52 years of specialized experience

Proof of the superiority of Bedford Cranes is found in the high percentage of *repeat orders* from important owners through the years.

In steel mills, power plants, and throughout industry . . . wherever superior performance is *expected,* owners enthusiastically recommend Bedford Cranes.

Available in all types and sizes . . . from five tons to 350 tons and up . . . for all kinds of indoor and outdoor services . . . each Bedford Crane is individually engineered and precision built for its specific application.

Built to the most modern standards and backed by more than 50 years of specialized crane building *and utilization* experience . . . Bedford Cranes have won fame the world over for advanced design and for safe, smooth, dependable performance.

You are invited to consult a Bedford Engineer on your next crane problem . . . with all the facts on the table, we believe you too will make *your* next crane a Bedford.

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"National" brushes come in more stock and catalog items than any other brand . . . *plus* the exclusive "National" *standardized* brushes sold at low, flat prices regardless of quantity . . . faster deliveries, lower costs.

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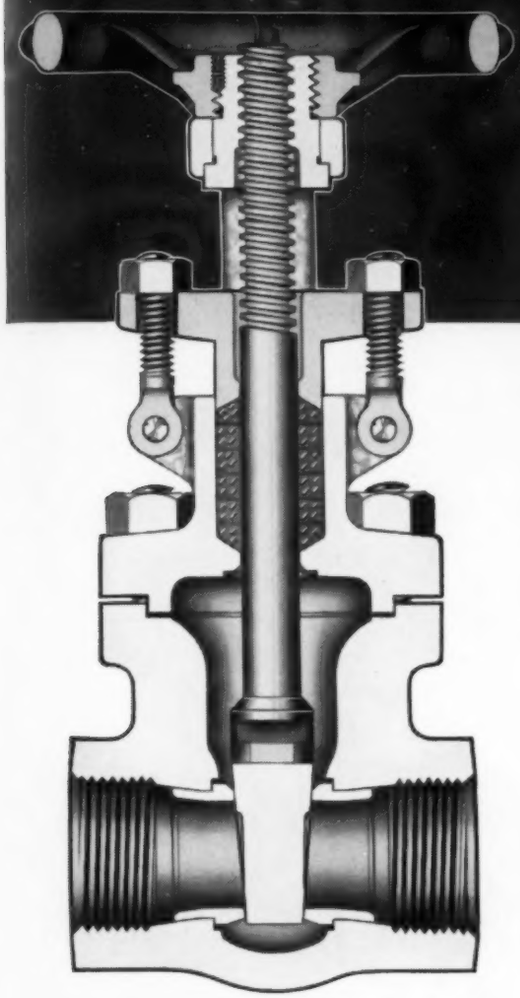
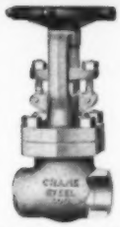
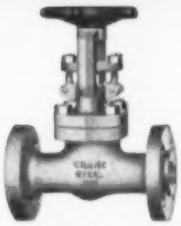




Screwed Ends—Union Bonnet or Bolted Bonnet

Socket-Welding Ends—Bolted Bonnet or Union Bonnet



Flanged Ends—Bolted Bonnet only

Look no further for dependable steel valves in sizes up to 2-inch. Whether you prefer the union bonnet or bolted bonnet pattern, you get refinements usually found only in larger, more expensive valves.

For example, you get a compact, weight-saving structure of high-quality carbon steel. Smooth operation and positive closure of the solid wedge disc are assured by a T-head disc-stem connection and full-length machined guide ribs. There's also an unusually large stuffing box filled with high-grade packing, a leakproof bonnet joint with retained gasket, a husky stem with outside threads, and many others. To simplify maintenance, Crane design includes swinging gland eye-bolts—plus a wide yoke with liberal working space around the gland.

BOLTED BONNET OR UNION BONNET

In the cross-section of the bolted bonnet pattern above, you can see the rugged *big-valve* construction. Bolted bonnet valves available in sizes ½ to 2-inch—union bonnet valves in sizes ¼ to 2-inch.

USER'S CHOICE OF TRIM

There's versatility to these quality Crane steel valves, too. You can have your choice of trim to suit your service—Class X Trim (Exelloy body and body seat rings) for oil or oil vapor—Class XW Trim (Exelloy seat rings, disc of hardened stainless steel) for steam or water. Union bonnet valves also available with Class L Trim (18-8 Mo Alloy seats, disc, stem) for liquids and gases up to 750° F.

Full details in 6-page folder AD-1881. Ask your Crane Representative next time he calls, or write direct.

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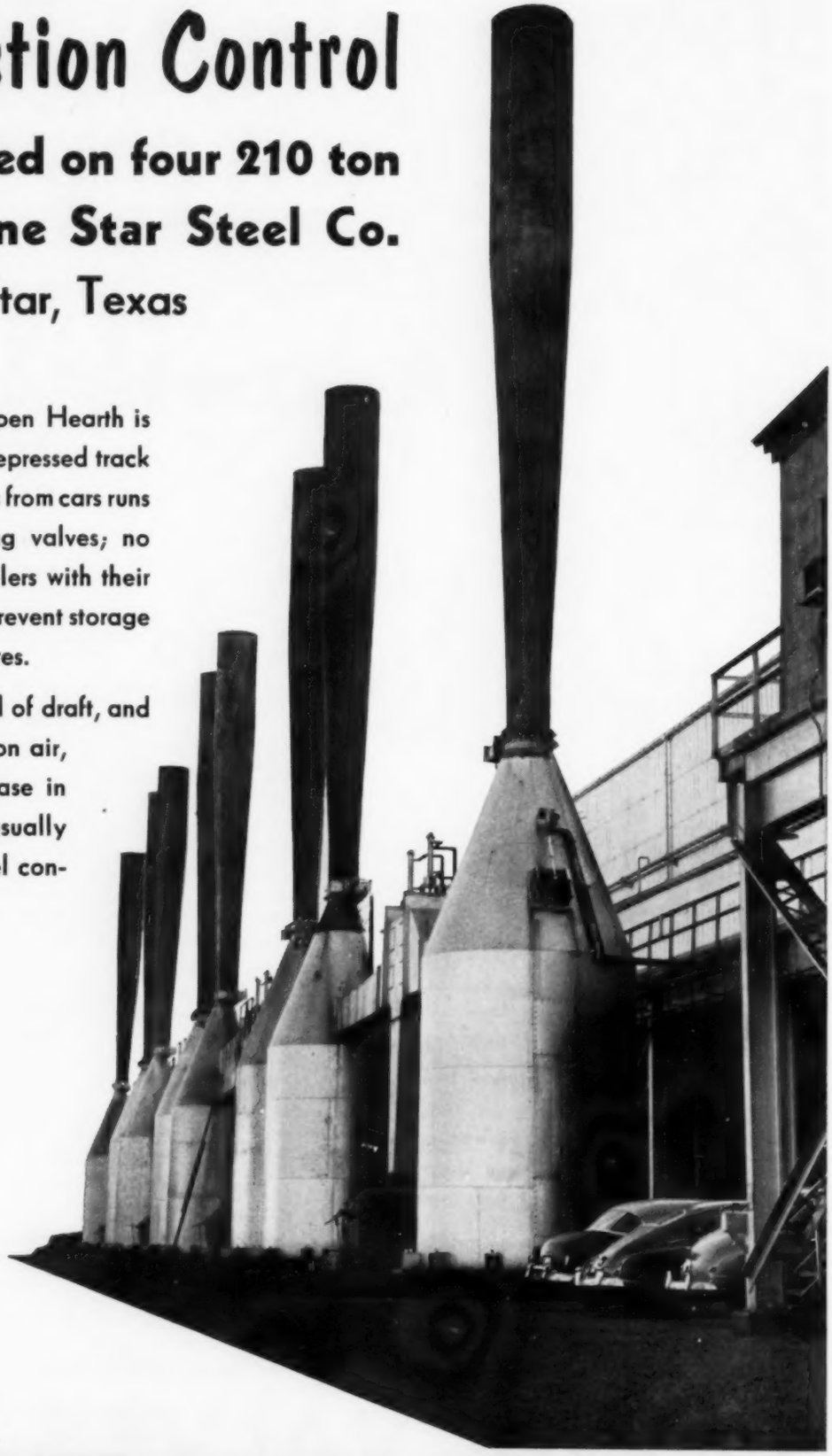
Morgan-Isley Combustion Control

has been installed on four 210 ton furnaces at Lone Star Steel Co.

Lone Star, Texas

The cellar of the Lone Star Open Hearth is a superintendent's dream. A depressed track to unload palletized refractories from cars runs from end to end. No reversing valves; no fans; no air piping, and no boilers with their auxiliaries to impede traffic or prevent storage of refractory materials and spares.

In addition, the absolute control of draft, and accurate metering of combustion air, with a possible generous increase in air temperature, makes for unusually high tonnage rates and low fuel consumption.



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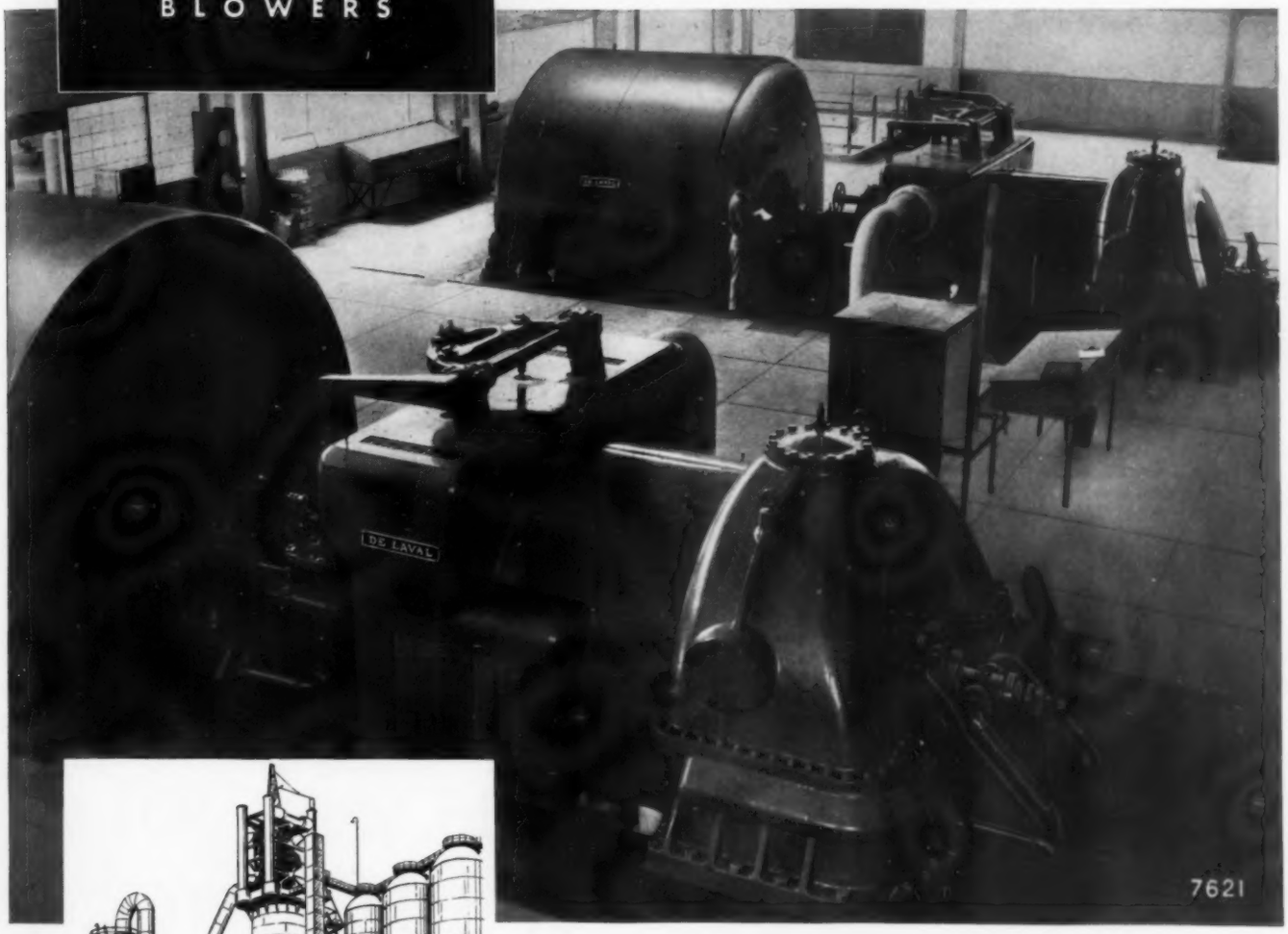
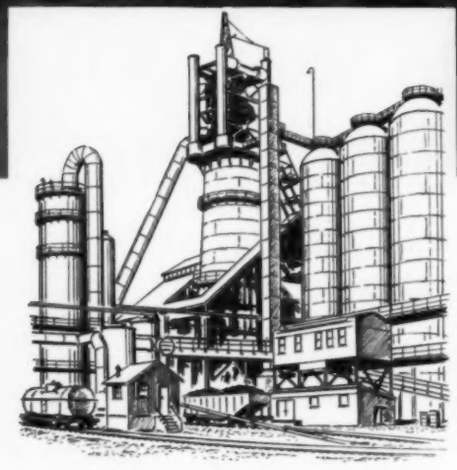
DE LAVAL STEEL MILL BLOWERS

designed for giant furnaces





These twin De Laval blowers, on the job in a leading mid-western steel mill, are among the largest ever built. Each is a five-stage unit with a rated capacity to deliver 121,000 cfm of air at 35 psig discharge pressure. Each is driven by a 15,220 hp, 2,500 rpm De Laval 16-stage steam turbine operating under steam conditions of 400 psig, 750 F with 28 in. vac.

The total weight of each De Laval turbine and blower is over 167 tons; the blower alone is over 212,000 lbs. Shafts of the turbine and blower were made large and heavy to meet the wide range of varying speed conditions required in blast furnace service. Outside diameter of the blower casing is 12 ft. and it is divided horizontally in the plane of the shaft. This permits raising the upper half of the casing for easy access to all interior parts. • For a quarter of a century, De Laval has pioneered in advanced blower engineering designs and practices. De Laval builds single and multi-stage centrifugal blowers and compressors for service in steel, gas and coke plants. Discuss your specific applications with a De Laval Sales Engineer.

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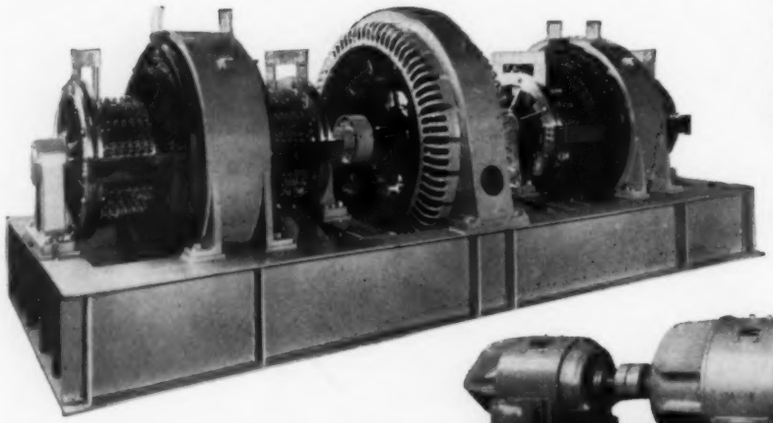
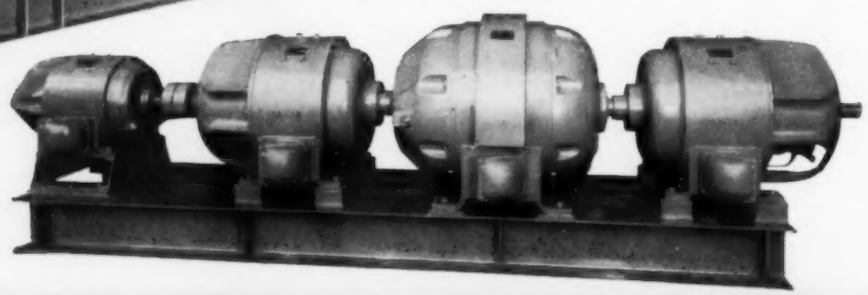
MOTOR GENERATORS

We're mighty proud of having the privilege of supplying the Low Voltage Motor Generator Sets at Kaiser's Electrolytic Tinning Line. A total installed capacity of 139,500 amperes of Columbia generators are giving superior, around-the-clock performance for the cleaning, pickling and plating operations.



One of a group of Columbia MG Sets installed at Kaiser Steel. This unit consists of two 7500 ampere 24 volt, 3750 ampere 48 volt, separately excited, D. C. Generators driven by a 600 HP, 360 RPM Synchronous Motor.



Multi-Unit Columbia Motor Generator Set consisting of two 50 KW, 250 Volt, D. C. Generators, and one 10 KW, 50 Volt, 200 Ampere booster Generator, all driven by 200 HP, 0.8PF, 1200 RPM Synchronous Motor.

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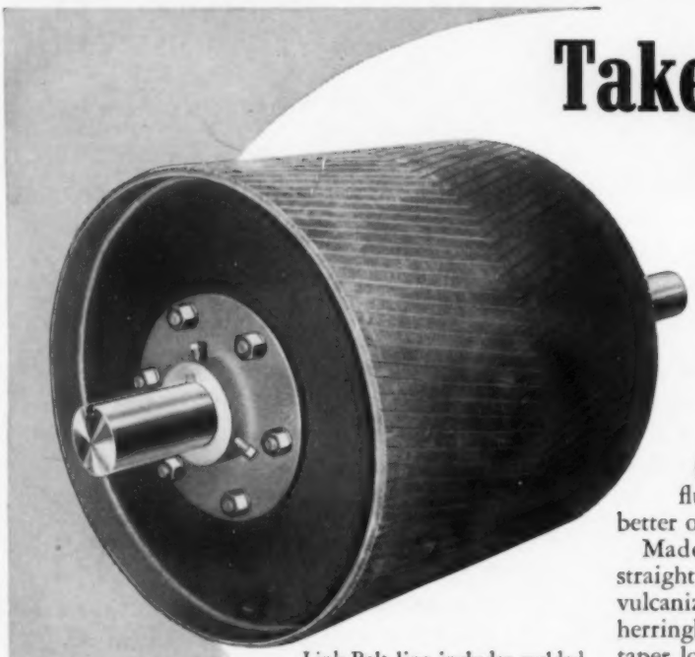
Takes the work out of field mounting

LINK-BELT assembles pulley on shaft—insures correct keyseat alignment

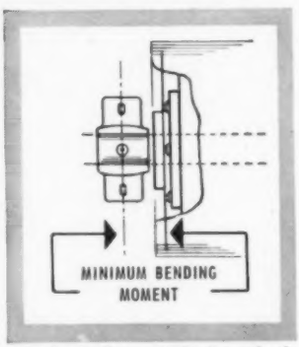


Link-Belt line includes welded steel and gray iron pulleys as well as welded steel slat pulleys. Popular sizes are stocked.

YES, you get a two-way dividend because Link-Belt mounts belt conveyor pulleys on their shafts at the factory. What's more, the flush-hub construction means better operation.

Made with either crowned or straight face, they are available with vulcanized lagging, either plain or herringbone. Your choice of bolted or taper lock hubs.

You can get complete information on belt conveyor pulleys from your Link-Belt salesman. Call him today.



Flush hubs minimize shaft deflection, cut hub bolt stress and disc deflection.

LINK-BELT

WELDED STEEL CONVEYOR PULLEYS

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The "Wonder Cement" for Resistance to High or Low Temperatures

For service to 3000° F., no refractory cement matches R. & I. Super #3000 for Bonding Strength — Hardness — Adhesiveness — Useful Life.

Reports from steel mills prove this plastic material, mixed with water and applied to make either thin or thick joints, has shown remarkable weld-tight resistance to shrinkage or spalling, abrasion and wear in blast furnace hearths and stack linings; soaking pit linings and covers; walls and arches of heating furnaces.

Used as a sealing wash coat, Super #3000 is practically impregnable, adding service life to existing refractories.

For hot patching, eroded or broken areas, it renews at low cost any refractory construction that would otherwise need complete replacement.

Everywhere Super #3000 shows definite improvement in lasting qualities over any bonding mortars previously used.

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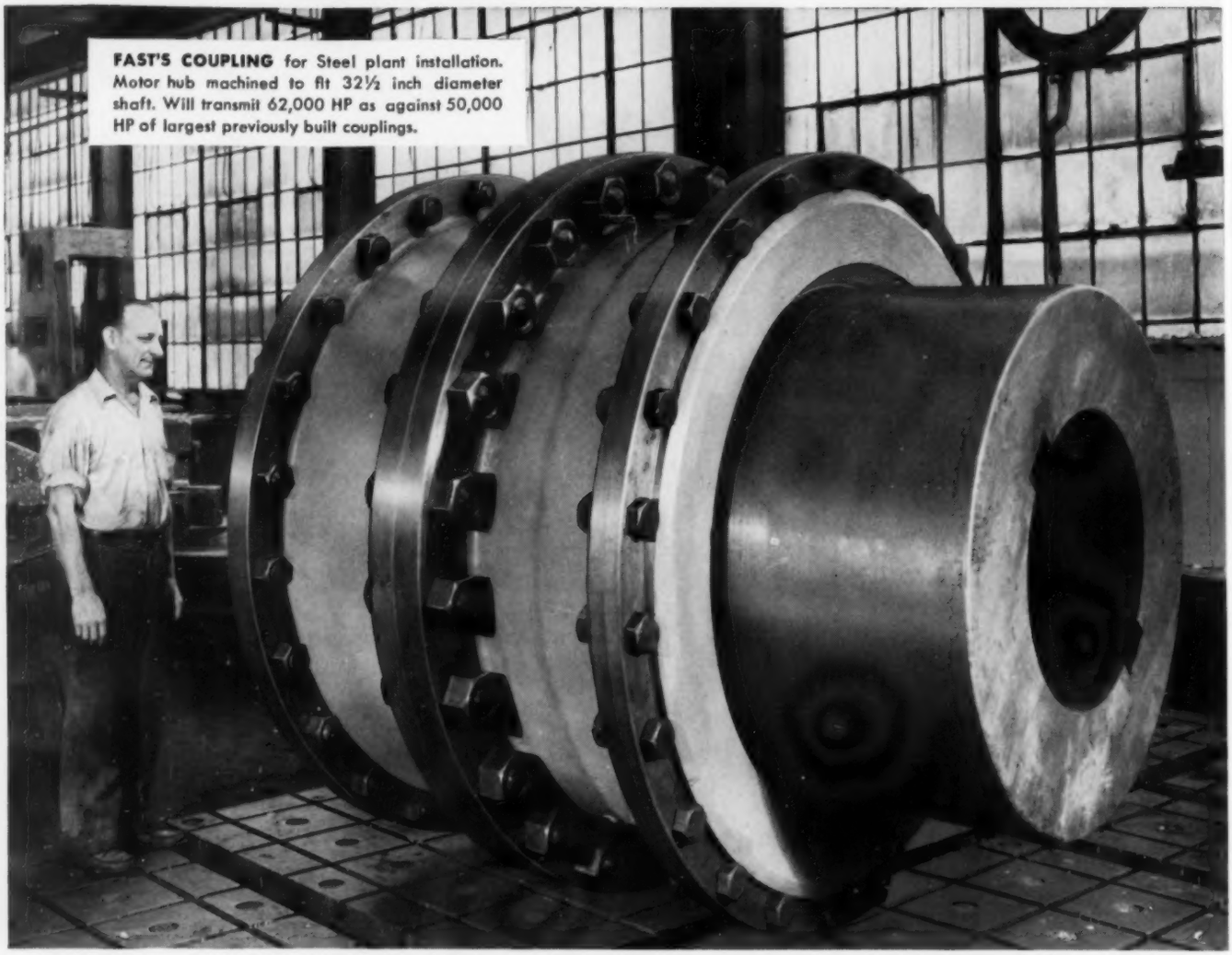

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To make a coupling that will transmit 62,000 HP and compensate for errors in alignment . . . that's more than a man-sized job.

But Koppers took on the project and this Fast's Self-Aligning Coupling is the result.

After six months of machining and assembly, this huge, *all metal* coupling is on its way to installation in a Milano, Italy, steel mill where it will carry power to a Mesta, 110-inch, four-high reversing plate mill.

It will transmit power from an electric motor to the equipment, and, at the same time, compensate for shaft misalignment and lateral float, give maximum power transmission efficiency, eliminate breakdowns and costly down-time.

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Remember, there's a Fast's Coupling for every power transmission application. Next time you have a coupling problem, call on Koppers . . . always ready to serve you. No obligation, of course. Also, for full details on Fast's Couplings for industry, mail this coupon.

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If you want to materially reduce down time on rolling mills due to clogged nozzles, try Spraying Systems descaling nozzles. Large orifice diameter permits passage of practically all particles that ordinarily clog other types of nozzles. Spraying Systems nozzles produce an effective uniform flat spray, free of streaks, with an impinging force equal to over 96% of the maximum potential. Typical user is the Homestead District Works of U. S. Steel illustrated above. Nozzles are made of hardened stainless steel in a wide range of capacities and spray angles. Your inquiry is invited . . . write for Data Sheet 3997.

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Also write for Data Sheet 4516 . . . Pneumatic Atomizing Nozzles for direct spray gear lubrication.

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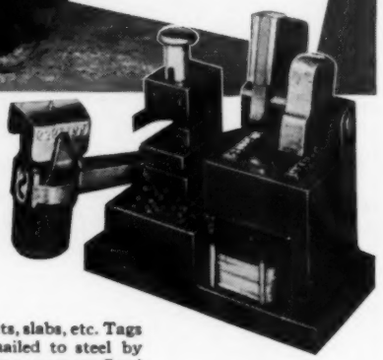
"SAFETY" TAG EMBOSSING and TAGGING OUTFIT



It's hard to believe, but it's true—this Outfit enables you to quickly nail metal identification tags to hot or cold steel ingots, billets, slabs, etc. Tags are embossed, pierced and nailed to steel by swinging hammer in the ordinary manner. Send for complete data today on this remarkable unit.

Write for Catalog 100.

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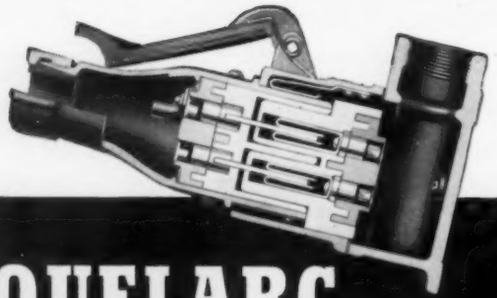

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QuelArc plugs and receptacles are available in a complete range of styles, 2, 3 and 4 pole types—grounded through shell or extra pole. Housings with threaded cap, plain cap or hinged spring door. Ratings 20, 30, 60, 100 and 200 amperes, 250 volts DC, 600 volts AC. Consult your Pylet Catalog 1100, Bul. 1140-2 for complete listings.

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Refractory Porcelain Specialties in stock or designed to meet specific needs. Flasks, retorts, crucibles, etc. and parts "custom-made" to do the job.

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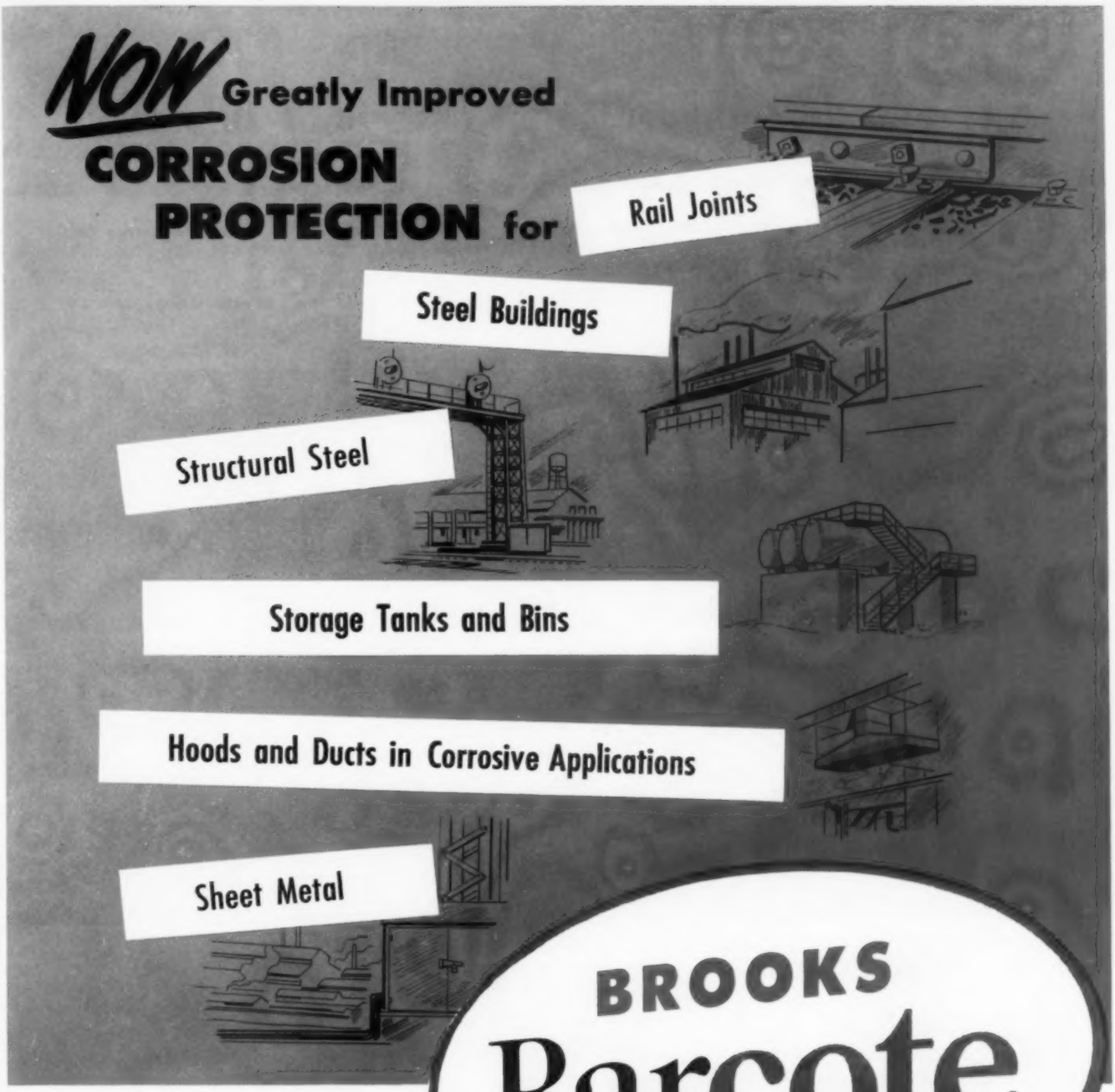
BEAVER FALLS, PENNA.

NOW Greatly Improved CORROSION PROTECTION for



BROOKS
Barcote

Brooks Barcote, which sets to a semi-hard coating of pure lubricant, provides exceptional corrosion protection in all the applications indicated. This new leaded-petroleum compound produces a film which expands and contracts without flaking, cracking, pulling away or blistering. Barcote resists the action of salt water, is soluble in petroleum solvents and never clogs spray equipment.

Write for Brooks Pamphlet 61.

- Low cost, with long service
- Flows at 0° F
- Has penetrating action sufficient to carry it behind scale and through rust

THE BROOKS OIL CO.

Since 1876

Executive Offices and Plant, Cleveland, Ohio
Executive Sales Offices, Pittsburgh, Pa.
Canadian Offices and Plant, Hamilton, Ontario
Cuban Office, Santiago de Cuba

Warehouses in Principal Industrial Cities

7 solid reasons why it pays to standardize on LINK-BELT IDLERS

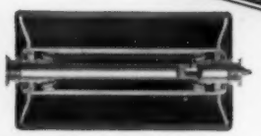
1 STRONG, RIGID FRAMES support rolls in perfect alignment. Rolls are securely held in place but can be easily removed for inspection and service.

2 CONCENTRIC ROLLS have smooth surfaces and rounded edges. Machine-made, continuous welds prevent entrance of dirt and moisture—assure hop-free rotation.

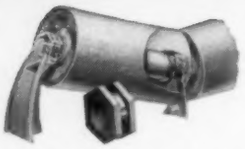
3 HUSKY, HIGHEST QUALITY BEARINGS, free and easy turning, provide concentricity and perfect alignment for smooth operation, minimum belt wear, low power requirements.

4 SAFE, CONVENIENT GREASE FITTINGS provide ease of lubrication. Extensions can be furnished for greater accessibility in out-of-the-way locations.

5 POSITIVE, COMBINATION GREASE SEAL unit retains lubricant, prolongs bearing life. The most effective seal offered in idlers today!



6 ROLLS consist of a counterbored outer shell plus a full-length, heavy central tube of 3/16-in. steel. Both tube and shell are welded to dished steel heads to maintain balance and bearing alignment.



7 HEX NUTS provide bearing adjustment at shaft ends and prevent rotation in service. Nuts prevent bracket from spreading under unusual impact.

Get the right idler from industry's most comprehensive line

Link-Belt makes more than 500 belt conveyor idlers in 34 types. You can select from light, medium or heavy-duty 20° troughing idlers, two types of 45° idlers, flat belt, belt training, rubber cushion and the new Link-Belt variable troughing idler. Most are built in a broad range of roll diameters and belt widths with matching return idlers. Ask your Link-Belt sales representative or distributor for new 48-page Book 2416.

LINK-BELT

BELT CONVEYOR IDLERS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.415

Industry News...

PRODUCTION OF MILLION TONS OF FINISHED STEEL HIGHLIGHTS KAISER RECORD FOR 1953

▲ Production of 1,064,668 net tons of finished steel products in 1953—the first year in the company's history finished steel output has passed the 1,000,000-ton mark—highlighted a record year for the Kaiser Steel Corp.

This represented a 10 per cent increase over the previous record year, and exceeded by more than 200,000 tons the combined output of finished steel by all mills in the seven western states for any pre-World War II year.

Other company highlights for 1953 were as follows:

1. The company's nine open hearth furnaces produced 1,528,648 tons of steel ingots, representing operation at 100 per cent of rated capacity. The ninth open hearth furnace, which started in January, helped make possible this 10 per cent increase in total tonnage.
2. Output of pig iron (as hot metal) from the three blast furnaces was 1,094,827 tons, up 12 per cent over 1952.
3. 1,759,437 tons of iron ore were mined at Eagle Mountain, Calif., a five per cent increase over 1952.
4. Output of 1,282,000 tons of coking coal at the company-owned coal mines at Sunnyside, Utah, was a 35 per cent increase over 1952.

The year 1953 saw the near completion of the company's $65,000,000 expansion program, which started in March 1952. In addition to the ninth open hearth furnace and the third blast furnace, other major units placed in operation included 90 new coke ovens, two additional stands to the 86-in. plate mill, as well as new facilities at the company-owned iron ore and coal mines.

In November the company announced an $8,000,000 expansion program for its Fontana, Calif., rolling mills that will increase production capacity of plate, sheet and tin plate by 120,000 tons a year, or approximately 17 per cent. A substantial portion of this program will increase the capacity of electrolytic tin plate production from 130,000 tons to 200,000 tons per year, to meet the needs of the large and growing can-manufacturing and food processing industries.

OVER $1,000,000,000 FOR PLANT EXPANSION

▲ Iron and steel companies spent over $1 billion to expand and improve their plants last year, American Iron and Steel Institute announced. With this large outlay, the third biggest in the industry's history, over $5.6 billion has been invested by the companies for new equipment and construction during the eight post-war years, 1946 to 1953 inclusive. Nearly all of the expansion and improvement has been privately financed. This outlay exceeds the total investment of the entire industry as of eight years ago.

An investment of approximately $775,000,000 will be made during 1954, according to estimates by the companies at the start of this year. With the addition of this amount, the postwar investment will rise to almost $6.4 billion.

The great investment in the future is not being made by merely one, or a few large companies alone. Medium and small size companies are sharing in the effort to provide more steel capacity, better working conditions and more jobs.

Among the facilities which came into operation in 1953 were about 500 new coke ovens and over 400 rebuilt ovens; several new blast furnaces; steelmaking furnaces; soaking pits; a new seamless tube mill; equipment for rolling sheets, strip and tin plate; a new bar mill; annealing equipment and many other facilities.

ANNOUNCES OPENING OF WEST COAST OFFICE

▲ The Electric Controller & Manufacturing Co., Cleveland, Ohio, announces the opening of a sales and engineering office at 6066 East Olympic Blvd., Los Angeles 22, Calif., with Mr. John R. Woodruff as Pacific Coast district manager.

DOCK EXPANSION INCREASES UNLOADING CAPACITY

The recent 1000 ft extension of its ore dock basin to 2200 ft is enabling the Bethlehem Steel Co. plant at Sparrows Point, Md., to unload with greater facility the approximately 7,000,000 tons of iron ore it normally receives annually. It is now possible to unload three large ocean-going vessels simultaneously while a fourth vessel (extreme right) prepares to leave after having discharged its cargo. The extension project required dredging to a 40-ft depth MLW and removal of 1,350,000 cu yd of material. Additional facilities installed were a 15-ton ore unloader and a 20-ton combination ore unloader and bridge. This extra equipment affords a greater unloading capacity of 2880 tons per hour.

10 cutting edges on one KENDEX* tool!

No tool grinding expense and *minimum* machine down time for tool changing—these are the advantages you obtain from multiple-edge Kendex "throw-away" insert tools. For example:

A Kendex round insert, used to bore 2½" cast iron stators, machined 300 pieces before one cutting edge dulled. Then, without removing the shank from the boring bar, the "button" was revolved to a new cutting position, until 3,000 stators were machined with the insert's 10 cutting edges. Best previous performance, by a conventional brazed tool, was 400 stators per tool grind.

Kendex precision-ground buttons have Kennametal's high wear-resistance, for long life. Screw-mounted, they can be rotated in seconds to new cutting positions without removing or resetting the tool holder . . . a great time-saving feature. When all cutting edges are used, the insert is thrown away—replacement cost is slight compared to that of regrinding.

Only Kennametal makes Kendex "throw-away" inserts. Ask your nearest Kennametal tool representative to help you apply this cost-saving tooling to suitable operations in your plant. Kennametal Inc., Latrobe, Pa.

*Registered Trade-Marks

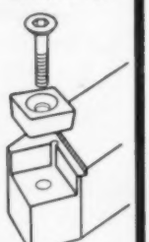
How KENDEX* Works

1

Hard, strong, wear-resistant Kennametal is molded into square, round, or triangular Kendex inserts, which are precision ground.

2

Kendex inserts are mounted to suitable tool holders with socket head screws.



3

When edge becomes dull, insert is turned to new cutting position. When all cutting edges have been used, insert is thrown away; no regrinding.

KENNAMETAL*

CEMENTED CARBIDE TOOLING THAT INCREASES PRODUCTIVITY

A-8 SALES OFFICES IN PRINCIPAL CITIES

STARTS PROCESSING UNIT AT UNIVERSAL PLANT

▲ United States Steel Corp. made another major forward stride in its district-wide smoke control campaign as Charles B. Baker, president, Universal Atlas Cement Co., announced the starting up of the new raw material processing unit at its Universal, Pa., plant.

Razing of the old cement plant began in October, 1952, and construction of the new modern cement-making units began last April. In the move to reduce smoke and dust at this operation, the cement company is eliminating a total of 38 smokestacks which have been operating for more than 40 years. When the modernization program is completed late in 1955, the new plant will have only two major smokestacks. All smoke funnelling through these stacks will be cleaned by mechanical dust-collectors and then by electrostatic precipitators.

The raw material mill is the first step in the production of cement. Here, limestone, slag, sand and blast furnace flue dust are dried and pulverized to powder consistency for baking in large kilns.

Mr. Baker pointed out that rebuilding of the plant into one of the most modern cement plants in the United States is a result of long-time engineering studies and is a major project in U. S. Steel's continuing program to reduce smoke and dust from Pittsburgh district plant operations.

RYERSON & SON OPENS NEW MILWAUKEE PLANT

▲ Joseph T. Ryerson & Son, Inc., steel service organization, has moved from its former location in Milwaukee, Wisc., to a new and much larger plant at 500 S. 88th St.

The new plant has approximately 170,000 sq ft of floor space, which is four times the capacity of the old plant at 320 S. 19th St. which the firm occupied for 28 years.

Construction of the new plant, consisting of two large building units and an office building on grounds that will be attractively landscaped, was begun early in 1953. Walls are brick and stainless steel, the steel portion employing a new sandwich type of construction in which the outside

UNDERGROUND GIANT

This underground locomotive is shown entering the Mathies Coal Co. mine where it is hauling record length loads of coal. The locomotive was designed and built by General Electric Co. at its Erie, Pa. locomotive works.

stainless wall is joined to galvanized sheeting inside with insulation between the two. Installation of the stainless steel remains to be completed.

With the opening of the larger plant, the company announced a change in the geographical area served from Milwaukee. Previously the Milwaukee plant concentrated its service in the city and immediately surrounding area. Now the territory served from Milwaukee includes practically the whole of the state of Wisconsin, the upper peninsula of Michigan, and a small portion of Canada.

In addition to carrying much larger stocks of carbon, alloy and stainless steel in a full range of sizes and shapes to satisfy the requirements of the manufacturing industries, the company stated that special emphasis has been placed on improved service to the construction industry. Reinforcing steel stocks have been considerably enlarged, with the Milwaukee plant now giving a complete detailing and fabricating service on concrete reinforcing bars and accessories.

RECEIVES ARMCO CORP. ANNUAL SAFETY AWARD

▲ The Piqua tubing division of Armco Steel Corp. was honored as the safest plant in the entire Armco organization.

The tubing division operated throughout 1953 without a single accident, and for the second straight year received the famous Armco "Iron Man" as its award.

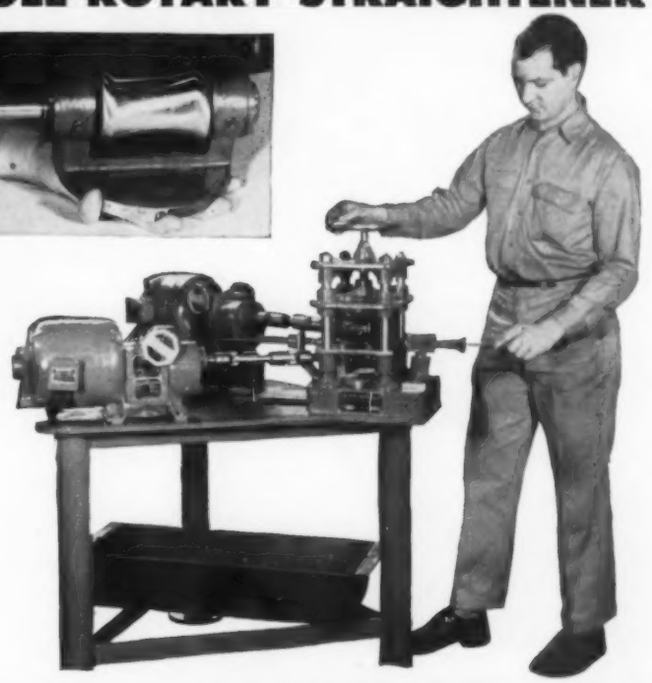
Presented by R. G. Adair, director of personal relations, the "Iron Man"

How To Precision Straighten 1/16" To 3/16" O.D. Round Bars And Tubes

MEDART

No. 000 TWO-MOTOR TYPE

2-ROLL ROTARY STRAIGHTENER



- The smallest mill duty 2-roll rotary precision straightening machine made. Straightens, sizes and polishes round tubes and bars from 1/16" to 3/16" O.D., and corrects out-of-roundness from end to end.
- Individual roll drive from variable speed motors equipped with integral speed reduction units, and interlocked for synchronization of roll speeds.
- Rolls made of Smavroc Alloy. Timken Bearing equipped.

Large Or Small—Medart Builds Them!

2-Roll Rotary Straightening, Sizing & Polishing Machines for tubes and bars from 1/16" to 9" or larger—or multiple-roll straighteners for pipe or thin-wall tubes up to 24". Whatever the straightening job, a Medart machine will do it *faster, better and at lower cost!*

Write For Catalogs

THE MEDART COMPANY 3535 DE KALB STREET ST. LOUIS 18, MO.

GOLDEN JUBILEE
1904 Chandeysson 1954

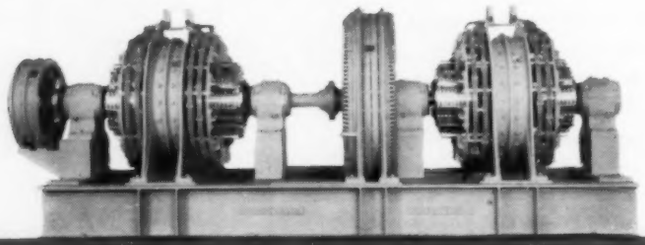
Dr. Pierre Chandeysson,
founder of the company.
1875-1953

50 YEARS

OF SPECIALIZING

HAS MADE Chandeysson MOTOR-GENERATORS

the most efficient, most dependable for Electrolytic Applications



1904 1954

A modern Chandeysson generator built for one of the country's largest automobile manufacturers.

One of the early Chandeysson generators still in use.

During all these 50 years there has never been a compromise with quality in a Chandeysson product. Only the best in materials and workmanship could create generators with such high quality that some of the original generators are still giving satisfactory performance today.

It has always been — and shall continue to be — the Chandeysson policy to build sturdy products with overload capacity that permits you to meet emergencies without damage to your power conversion equipment.

Many hundreds of America's most prominent industrial producers such as large automobile companies, have chosen Chandeysson Generators to serve their needs where constant production, without interruption, is an absolute requirement.

Chandeysson products are sold through distributors with experience and training that may be of value to your technical staff. Write for your distributor's name.

CHANDEYSSON ELECTRIC CO.
4076 Bingham Avenue, St. Louis 16, Missouri

is a four-foot bronze statue of a steelman. It is annually awarded to the Armco plant with the best safety record.

The "Iron Man" was accepted by William Stahly, manager of the tubing division, and it will remain at the Piqua plant throughout 1954, or as long as that division maintains the best safety record.

C. M. Allen, chief safety engineer for Armco, pointed out that the Piqua plant has not had an accident since May 29, 1951—a total of 973 days.

PLAN NEW CLEVELAND ENGINEERING CENTER

▲ Exemplifying the growth and importance of engineering in the industrial northeastern Ohio area, a $1,378,000 building and development program for the construction of a new downtown engineering center has been announced by the Cleveland Engineering Society, Cleveland, Ohio.

Plans for the project, which will be completed as the society prepares for its 75th anniversary, have been outlined at a number of special meetings for the membership and the area's industrial leaders.

To be known as the Cleveland Engineering Center, the two-story structure will be of contemporary design and will provide facilities aimed at making it the focal point of all engineering activities in northeastern Ohio.

Some 36,000 square ft of space will be provided in the new center. It will have an auditorium seating 950 people and dining rooms equipped to serve 400 people.

FORM NEW INDUSTRIAL ENGINEERING DIVISION

▲ Arthur G. McKee & Co. of Cleveland, Ohio, large designer and builder of blast furnaces, open hearths and petroleum refineries, is taking steps to broaden its activities in the engineering field.

H. E. Widdell, president, announced the formation of a new industrial engineering division for the purpose of handling engineering contracts for industries other than the steel and petroleum.

Mr. Widdell also announced appointment of David M. Checkley, formerly vice president of the Cleveland consulting engineering firm of J. Gordon Turnbull, Inc., as general manager of this new division.

TO EXPAND FACILITIES AT MIDLAND FOUNDRY

▲ A quarter-million-dollar expansion program for its Midland, Pa., foundry was announced by Mackintosh-Hemphill Co., pioneer machinery and roll manufacturer.

New equipment being acquired for the plant includes a huge Ingersoll vertical milling machine, one of the largest ever built. The unit was designed for machine finishing universal couplings on blooming mill rolls and rolls for other heavy duty rolling mills.

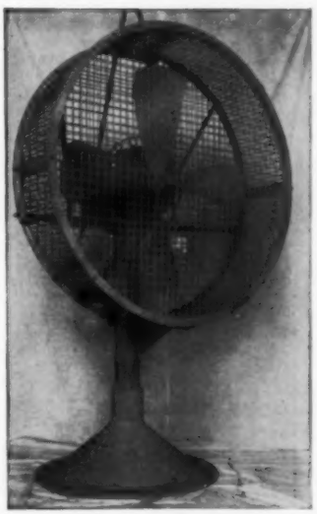
Located on a 20-acre tract on the Ohio River, the Midland plant was originally established in 1907 by Pittsburgh Iron & Steel Foundries Co. It was merged with Mackintosh-Hemphill in 1922.

In addition to steel rolls, Midland

IS HEAT SLOWING UP YOUR WORKMEN?

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS



TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY

245 MAIN ST: HARMONY, PA:

PICKLING ACID INHIBITOR.....

Trade Mark

RODINE

Reg. U.S. Pat. Off.

"Rodine" more than pays for itself in savings of acid and metal. More uniform pickling and better pickled surfaces are obtained when "Rodine" is used in acid pickling baths.

When sheet steel is pickled continuously, "RODINE" improves the surface and prevents "pickle burning" in prolonged pickling.

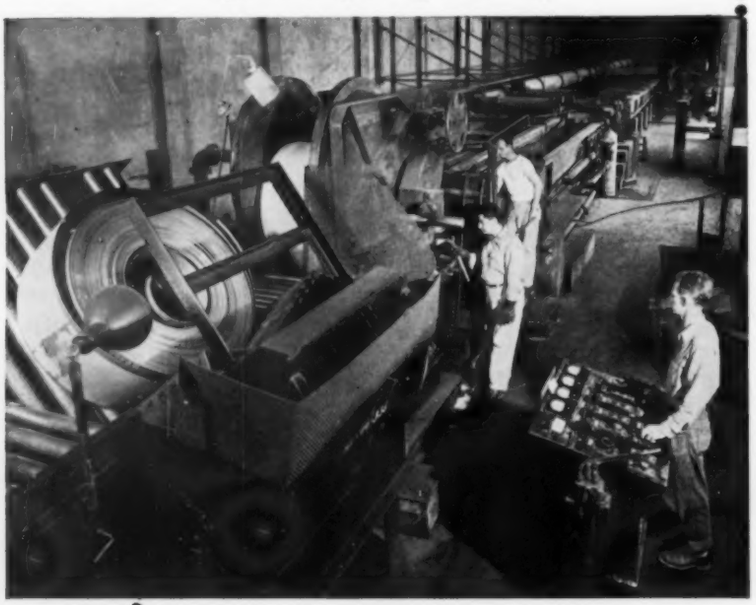


Photo by courtesy of
Kaiser Steel Corporation, Fontana Works, Fontana, California

CHEMICALS ACP PROCESSES

AMERICAN CHEMICAL PAINT COMPANY

General Offices:

AMBLER, PENNSYLVANIA

Detroit, Mich. *Niles, Calif.* *Windsor, Ont.*

produces the Johnston corrugated cinder pot which is used for blast furnace and open hearth slag disposal.

Carbon steels and special alloy steels are made in two 50-ton acid open hearth furnaces. The foundry has a pattern shop, molding floor, heat-treating equipment, machine shop and quality control laboratories.

ANNOUNCES RECORD INGOT CAPACITY

▲ The 1953 increase of about 6.8 million tons in the steel capacity of the United States took place in 14 states, according to American Iron and Steel Institute. The capacity of the nation is now 124.3 million tons of ingots and steel for castings annually. This is the highest level ever achieved.

The largest gain occurred in Ohio, where the combined capacity of steel plants in that state rose 1,744,800 tons. Ind. had the second largest increase last year, 1,276,500 tons. Other major increases included: Ill. 1,079,600 tons; Mich., 744,880 tons, Pa., 685,900; Tex., 520,180; Ala., 376,000; Md., 350,000; N. Y., 254,830; and Utah, 204,000. Table shows breakdown of steel capacity by states:

STEEL CAPACITY OF STATES

Net Tons, Ingots and Steel for Castings

State	Capacity 1/1/54
Ala.	4,721,520
Calif.	3,158,470
Colo.	1,485,000
Conn.	188,280
Del.	494,570
Ga.	300,000
Ill.	10,800,200
Ind.	14,968,500
Ky.	1,820,420
Md.	5,884,000
Mass.	287,000
Mich.	6,550,780
Minn.	973,000
Mo.	630,000
N. J.	242,800
N. Y.	6,349,530
Ohio	24,388,060
Okla.	70,920
Ore.	110,000
Penna.	34,037,460
R. I.	93,000
Tenn.	38,000
Texas	1,789,900
Utah	1,879,000
Va.	12,000
Wash.	390,000
W. Va.	2,668,000
Total	124,330,410

how many thousands of dollars do these tools cost you ?

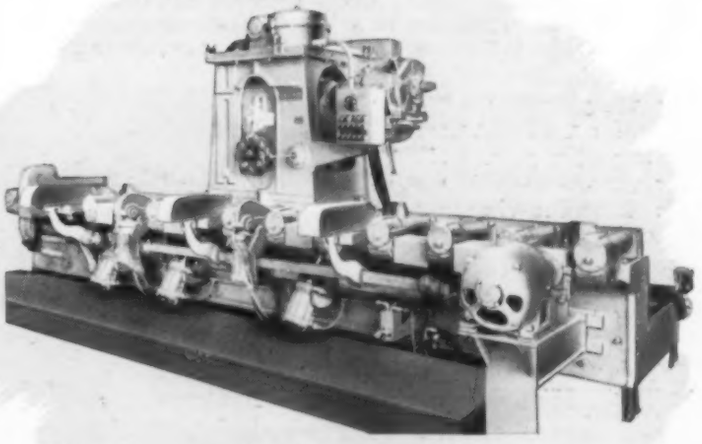
You can buy hammers and torches for a few dollars and operate them for a few quarters a day. BUT, consider the additional thousands of dollars these tools cost you in . . .

High per-ton conditioning labor cost • Loss of valuable chips • Excessive remelting • Heavy inventories necessary to maintain schedules • Disruption of rolling schedules • Manpower turnover • Production loss through accident and fatigue.

BONNOT BILLETEER CAN SAVE YOU THESE THOUSANDS OF DOLLARS

Finger-touch controlled Bonnot Billeteer converts multi-horsepower force into *smooth high-precision operation.* It provides a dependable flow of conditioned billets without dangerous, nerve-racking drudgery and all the "extras" that make manual conditioning costs especially prohibitive in view of Bureau of Labor Statistics figures showing LABOR COSTS UP 157% SINCE 1939.

Bonnot BILLETEERING does a better job ten times faster at a saving of 56% . . . and makes the billetshed a preferred place to work. Let us show you how many thousands of dollars the Billeteers can save in your mill.

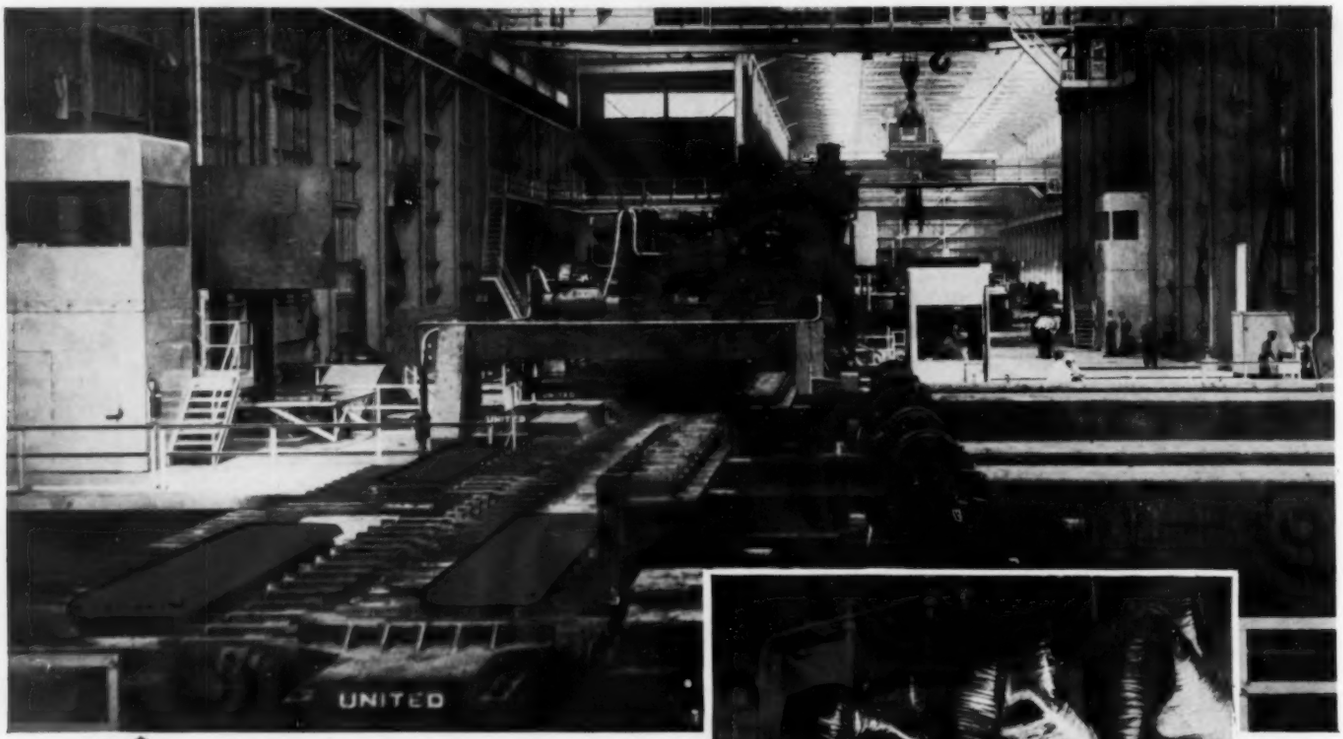


Engineered For Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO

Also Manufacturers of — SAWING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES CRUSHING • DUST PUG MILLS • SINTER PLANT PUG MILLS

FOR DEPENDABILITY, GRANITE CITY STEEL SPECIFIES OKOLITE-OKOPRENE CABLES



View of the new blooming mill at the Granite City Steel Co. plant in St. Louis from finished slab end. The entire mill, from the 5,000 hp motors for the two rolls to the control circuits, is wired with Okolite-Okoprene.

Simplicity of termination is one important reason for the trend to rubber-insulated high voltage cables. These are 12 kv rated Okolite insulated cables at the rear of the 6.9 kv motor switchgear.

Sverdrup and Parcel, Consulting Engineers
J. Livingston and Company, Electrical Contractors

Continuous operation was a prime factor in drawing up specifications for the expansion of the Granite City Steel Company plant in St. Louis. Every piece of equipment, including the electrical wires and cables, was selected on the basis of 24-hour-a-day operation.

High voltage distribution and low voltage control circuits are all wired with Okolite-Okoprene, the mold-cured, rubber-insulated cable that has established a reputation for dependability and long service life in industrial plants as well as utilities. Okolite insulation, which is applied by the Okonite strip-insulating process, is a thoroughly proved high voltage, natural rubber, oil base compound that resists heat, moisture and ozone. The Okoprene sheath, securely bonded to the insulation, provides a non-flammable weatherproof covering unharmed by long exposure to sunlight, acids, alkalies, fumes, heat and most oils.

For additional information on Okolite-Okoprene cables, write for bulletin IS-9000, The Okonite Company, Passaic, New Jersey.

OKONITE insulated cables

2111

ROLLWAY BEARING CO. MOVES SALES OFFICE

▲ The Philadelphia, Pa., sales office of the Rollway Bearing Co., Inc., Syracuse, N. Y., has been moved to Room 803, Beury Building, 3701 N. Broad St. William B. Allison, engineering representative, is in charge.

ANNOUNCES ADDITION TO FIELD SALES FORCE

▲ Sixteen sales engineers were recently added to the field sales force of Minneapolis-Honeywell Regulator Co.'s industrial division in 12 branch offices located in 11 U. S. cities and two Canadian cities, it was announced by J. A. Robinson, field sales manager. The appointments were in line with the division's planned growth program designed to meet expanded industrial demand for instruments. Investments for such equipment made by industry as capital outlays has increased more than eight times over the prewar rate, spreading over more than one-half of the 304,000 manufacturing firms in the country.

At the same time Mr. Robinson reported that 20 service engineers were also added to the firm's field sales force taking assignments in 17 U. S. cities and two Canadian cities.

ALLIS-CHALMERS TO ENLARGE INDIANA WORKS

▲ Allis-Chalmers Manufacturing Co. announced the completion of plans to enlarge the manufacturing facilities at its Terre Haute, Ind., works. The additional 84,000 sq ft will afford production facilities to manufacture component parts for transformers, switchgear and circuit breakers, the majority of which are presently subcontracted.

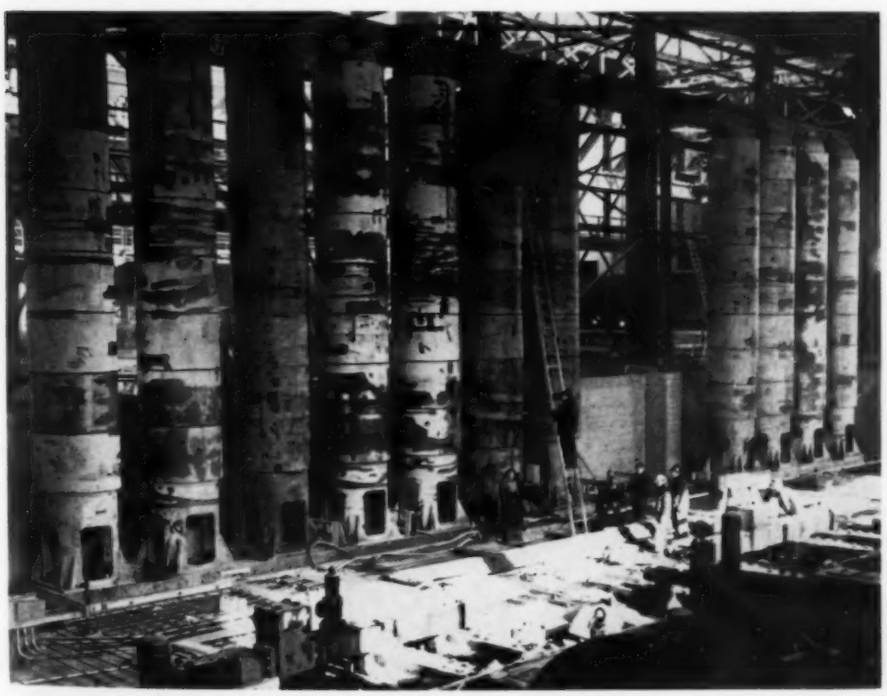
The building, a one-story structure, will be 200 ft by 400 ft with three bays. Facilities will include shop offices, rest and locker rooms. It is hoped that production in the new facilities will get underway by the end of 1954.

FURNACE CONTRACT AWARDED G. J. HAGAN

▲ Alan Wood Steel Co. has awarded a contract to George J. Hagan Co., Pittsburgh, Pa., for a 55 ft rotary hearth slab heating furnace for their plate mill at Conshohocken, Pa.

GIANT BOTTLES HOUSE WATER FOR HEAVY PRESSES

Seven pumps totaling 10,500 hp will charge these giant steel bottles, each 38 ft tall, with water at a pressure of 4500 lb per sq in. required for 50,000 and 35,000 ton die forging presses. The installation at the Wyman-Gordon Co., Worcester, Mass. was designed and is being built by Loewy-Hydropress for U. S. Air Force heavy press program.

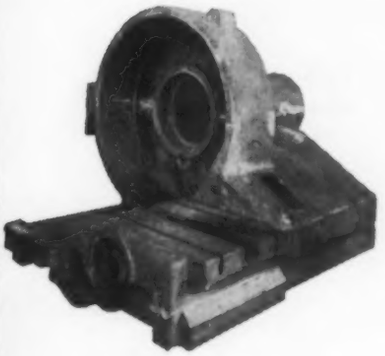


Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

Gray Iron Castings

Castings of any size up to 80,000 pounds. Hyde Park facilities are equal to your every requirement



Machine Castings
Lathe Beds
Housings
Pinion Housings
Mill Housings
Shoe Plates
Layout Plates
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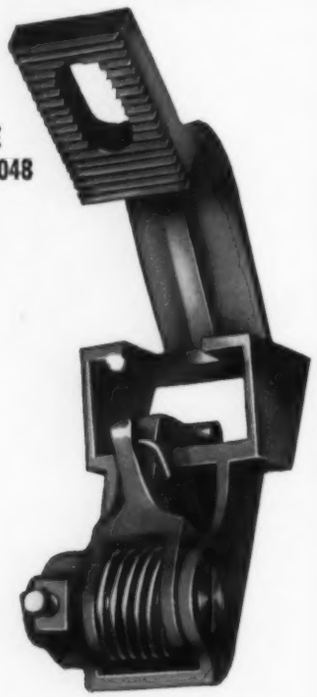
Hyde Park
FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland County, Pa.
ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

Pick your EXACT type BRUSH HOLDER

We design them FOR....

- INDUSTRIAL MOTORS
- CRANE MOTORS
- HOIST MOTORS
- MILL MOTORS
- MINE MOTORS
- CONTROLLERS
- ROTARY CONVERTERS AC-DC
- RAILWAY MOTORS



TYPE PB-3048

When your specifications demand BRUSH HOLDERS with high wearing qualities, low maintenance cost — pick from our more than 1,000 types, or have our engineers design your special type.

TYPE PB-3048, industrial, shown is one of many designed and produced for specific applications. . . . The 'something special' in BRUSH HOLDERS is produced by the specialist. Ask FLOWER

WRITE FOR CATALOG 41

FLOWER PHILADELPHIA SINCE 1907

D. B. FLOWER MFG. CO.

1217 Spring Garden Street, Phila. 23, Penn

The furnace will be equipped with automatic charging and unloading equipment as well as automatic combustion control, automatic temperature control and automatic fuel change-over to provide a completely automatic installation.

This is the first application of a rotary hearth furnace for heating slabs and is a part of the modernization program being carried forth by Alan Wood Steel Co.

BEGINS EXPANSION AT ELLWOOD CITY

▲ Mathews Conveyer Co., Ellwood City, Pa., announces that ground breaking has begun for an extensive expansion program. The plan involves the construction of a new office and engineering building and an addition of approximately 25,000 sq ft to the present manufacturing area, all to be completed within one year.

The office and engineering building will be a three-story brick structure, which will afford greatly improved facilities for engineering, manufacturing and shipping. The program provides for considerable expansion of the conveyor assembly department and will allow more available space for all manufacturing operations. It is the largest building program ever undertaken by the company in its 50 years of operation.

JESSOP STEEL ACQUIRES DETROIT SALES FIRM

▲ Jessop Steel Co., which recently stepped up marketing activities in Canada and France, disclosed it is making a new drive for business in three states with acquisition of a Detroit, Mich., firm.

Frank B. Rackley, president, said his specialty steel firm purchased the former Jessop Steel Sales Co., an independently-owned warehousing organization which had the sales franchise for Jessop Steel products in Michigan.

The Detroit company's operation will be expanded to include the distribution of Jessop products in Toledo and Cleveland, Ohio; and Chicago, Ill., as well as Michigan. The company will operate as a division of Jessop Steel Co. under the direction of John R. Harbaugh, assistant vice president in charge of sales, who is moving to Detroit. Andrew J. Scheirer will be manager of sales.

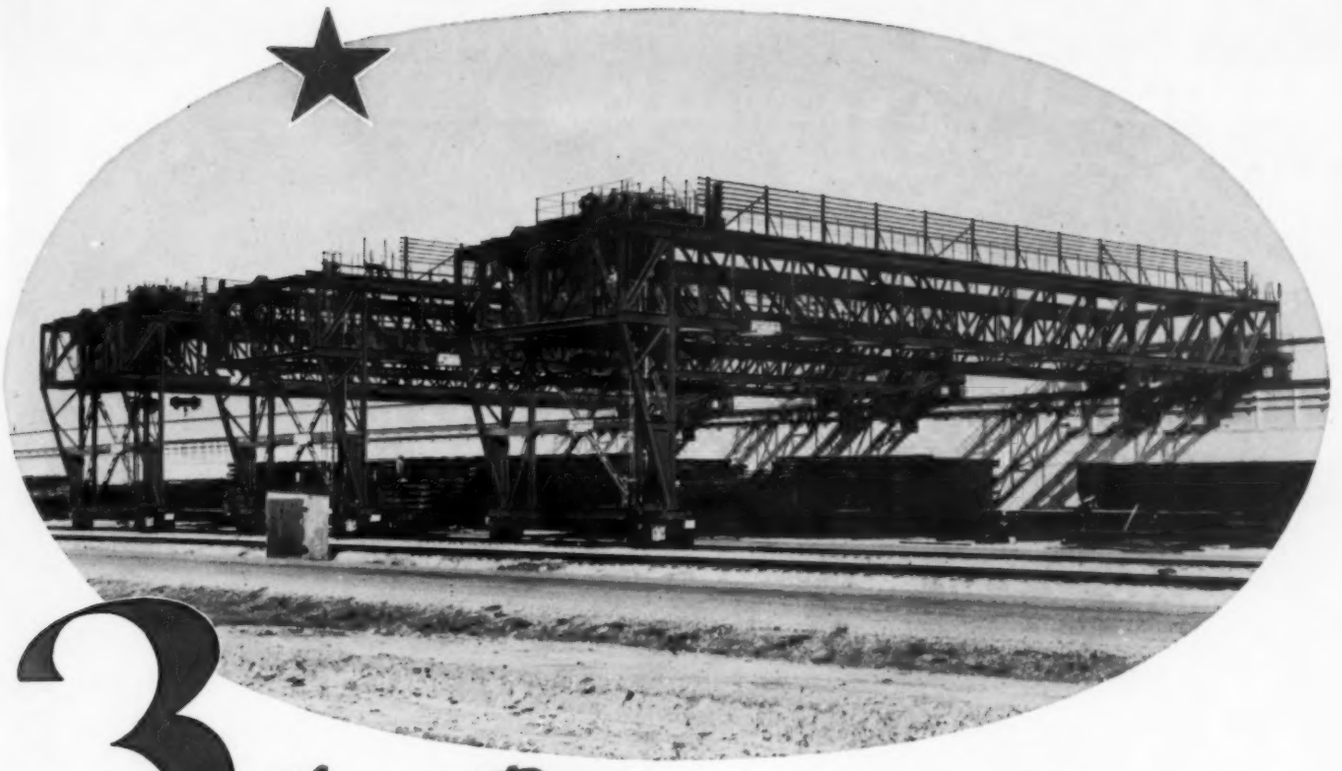
The expanded operation in Mich., Ohio and Ill. caps a series of moves which has seen Jessop Steel enter the Canadian market with construction of a new plant at Wallaceburg, Ontario. The first 8,000 sq ft unit of the plant was completed last month and warehousing activities are underway. The Canadian operation is called Jessop Steel of Canada, Ltd. It stocks precision ground flat steel, high speed tool bits, carbon and alloy steels, oil hardened die rings and stainless strip and sheet. This plant will begin production soon on such specialty products as cast to shape items, ground tool steels and tool bits.

KENNAMETAL TO BUILD DETROIT FACILITIES

▲ Kennametal, Inc., of Latrobe, Pa., is now engaged in a further expansion program. Company officials have announced that a contract has been let for the construction of a new manufacturing plant and office building in the Detroit, Mich., area. Address of this latest addition to the list of Ken-

MAMMOTH INGOT

Largest rectangular ingot ever cast at the Bethlehem, Pa., plant of Bethlehem Steel Co. is stripped from a mold measuring 70 x 155 x 200 in. The steel ingot, weighing 225 tons, will be forged into a crosshead support for a 35,000-ton die forging press which will produce airplane parts under the Air Force heavy press program. Loewy Construction Co., N. Y. is constructing the press.



3 Heyl+Patterson Gantry Cranes

"KEEP THE PIPE MOVING" at the New Pipe Mill of LONE STAR STEEL COMPANY

Newly-formed steel pipe comes off the production line at a rapid rate at the Lone Star Steel Company's new pipe mill, Lone Star, Texas.

As the finished pipe moves to the storage yard, one of three Heyl & Patterson Traveling Gantry Cranes unloads the pipe from the transfer car and carries it directly to railroad car or truck for shipment or to a spot in the yard for storage.

All three 15-ton H & P cranes, each equipped with a man-trolley, move over the entire span of the storage yard, unloading and transferring pipe without delay.

These three gantry cranes, as well as a 40-ton overhead crane operating inside the slabbing mill, were designed and fabricated by Heyl & Patterson and erected under the guidance of a Heyl & Patterson erection superintendent.

When your problem concerns transferring, loading or unloading pipe, ore, coal, slag or any heavy bulk material . . . remember Heyl & Patterson's ability to do the WHOLE job—All the Way from Design to Erection. Since 1887 Heyl & Patterson has designed, fabricated and erected all types of Heavy Bulk Materials Handling Equipment for the world's major industries.

Ore Bridges
Railroad Car Dumpers
High Lift-Turnover-Rotary
Coal Preparation Plants
Coal & Coke Handling Equipment
Boat Loaders and Unloaders
Rotary Mine Car Dumpers
Coal Crushers
Coal Storage Bridges
Car Hauls and Boat Movers
Bradford Breakers
Refuse Disposal Cars
Thorsten Coal Sampling Systems
Kinney Car Unloaders
Pig Iron Casting Machines
Cyclone Thickeners
Thermal Dryers
The Drying Dutchman
Reineveld Centrifugal Dryer

Heyl+Patterson, Inc.
"SINCE 1887"
55 FORT PITT BLVD. PITTSBURGH 22, PA.

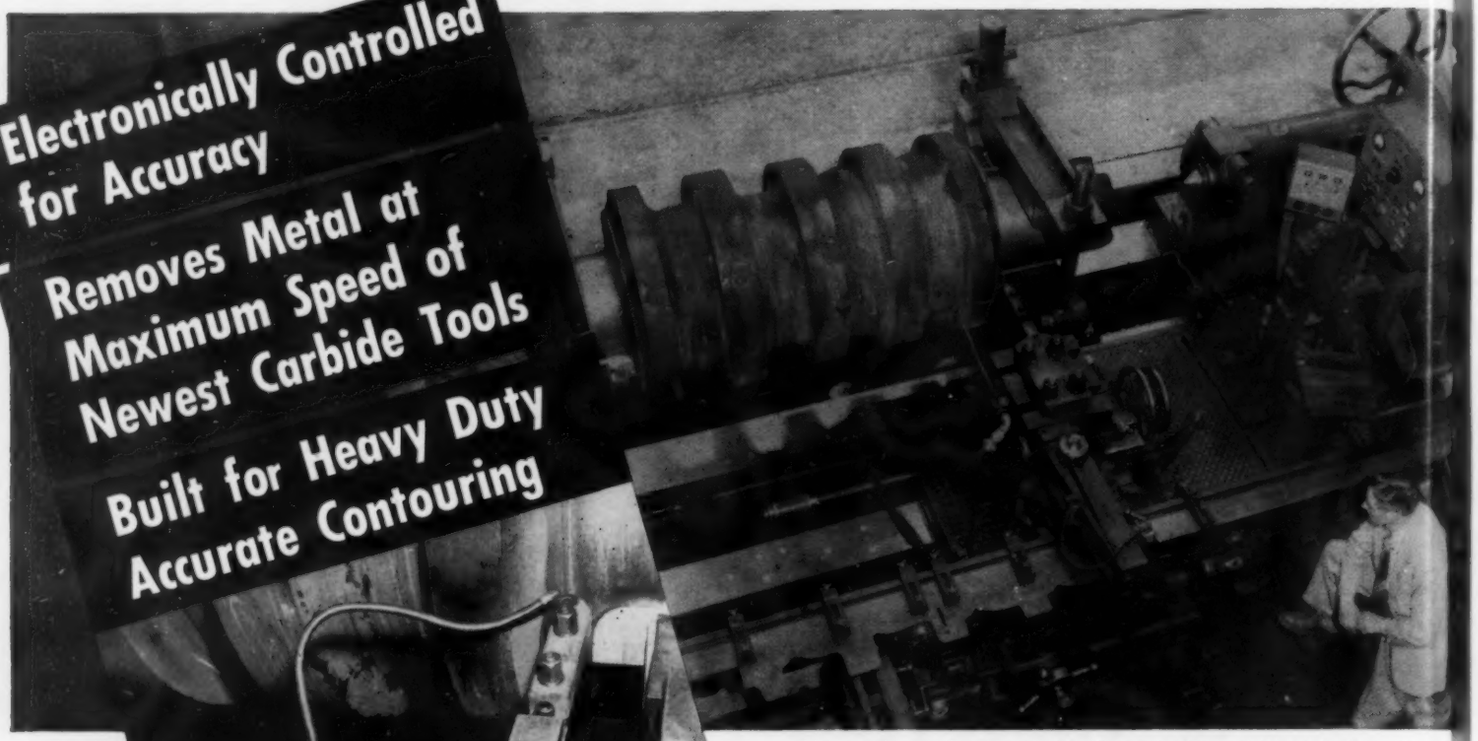
Heavy Bulk Materials Handling Equipment
All The Way from Design to Erection

MACK-HEMP 60" Automatic Contour Turninq Lathe

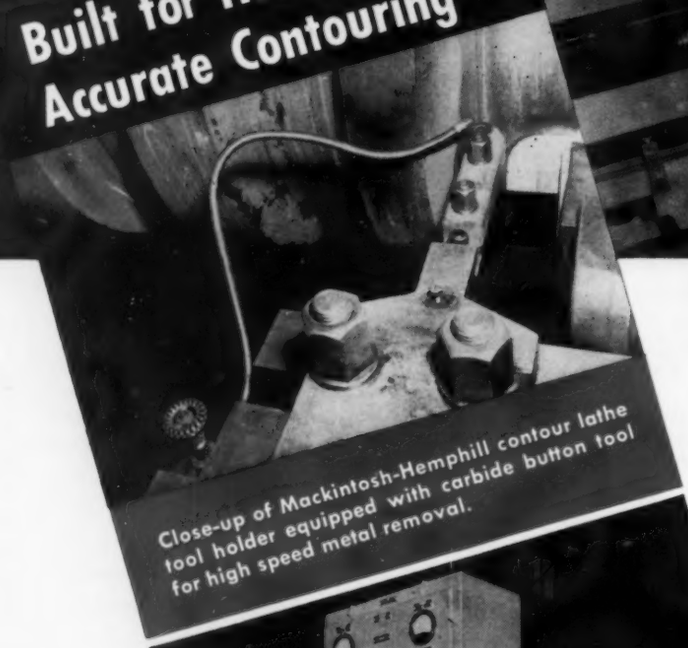
Electronically Controlled for Accuracy

Removes Metal at Maximum Speed of Newest Carbide Tools

Built for Heavy Duty Accurate Contouring



View of working area, Mackintosh-Hemphill 60-inch automatic contour lathe. Machine is turning a cast steel shape roll mounted on neck rests.



Close-up of Mackintosh-Hemphill contour lathe tool holder equipped with carbide button tool for high speed metal removal.

Control panel and cabinet housing. Raytheon electronic equipment for Mackintosh-Hemphill contouring lathe is mounted near operator's seat on lathe carriage.

The Mack-Hemp 60" Automatic Contour Turning Lathe, the largest unit of its type ever made, is the only large roll-turning lathe that contours roll bodies while rolls are neck-supported in housings rather than on centers. Rolls up to 54 inches in diameter and 20 feet long can be accommodated in the lathe. Present roll shop practice calls for surface speeds of 60 to 80 feet per minute on iron and over 200 or more feet per minute on steel.

Contour duplication is achieved by the combined action of a cross-feed motor and a longitudinal feed motor, both controlled electronically.

Other outstanding features:

- ample weight, power and rigidity to insure smooth cutting and to handle full present and future cutting tool potential.
- easy and accurate stylus and template adjustment.
- controls, tool and template holder—all directly visible to operator.
- hardened and ground wearing plates on all bed ways and cross feed slide.
- vibration free, heavily reinforced tool holder for fast cutting with the newest carbide tools.

If you want to learn more details about these unusual lathes and what is being accomplished in the nation's largest steel mill roll shops—**write for new publication, PE-54.**

MACKINTOSH-HEMPHILL COMPANY · PITTSBURGH U.S.A.

MACKINTOSH-HEMPHILL CO.

Makers of the Rolls with the Striped Red Wabblers

PITTSBURGH AND MIDLAND, PA.

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: rolls . . . improved Johnston patented corrugated cinder pots and slag handling equipment . . . Mackintosh-Hemphill rotary straighteners . . . heavy duty engine lathes . . . shears . . . steel and special alloy castings . . . completely integrated strip mills . . . shape straighteners . . . end-thrust bearings

nametal's facilities will be 10201 Capital Ave., Oak Park, Mich.

The new plant, together with the necessary stock and equipment, is scheduled for completion on April 1, 1954. Ample vacant property is being held for further prospective expansion.

ANNOUNCES FORMATION OF ENGINEERING FIRM

▲ Establishment of General Engineering and Manufacturing Co., Chicago, Ill., has been announced. The firm, blast furnace and control specialists, will have headquarters at 1140 E. 87th St., Chicago 19, Ill.

PYLE-NATIONAL OPENS DISTRICT SALES OFFICE

▲ Pyle-National Co., manufacturers of electrical products and air distribution equipment, announce the opening of a downtown district sales office, room 707, Railway Exchange Bldg., 80 E. Jackson Blvd., Chicago 4, Ill., under the direction of John H. Devol, district manager.

KOPPERS TO BUILD DEVELOPMENT LAB

▲ Construction of a new mechanical development laboratory devoted to the refinement and adaptation of present products and processes plus the development of new products for the metal products division of Koppers Company, Inc., was announced.

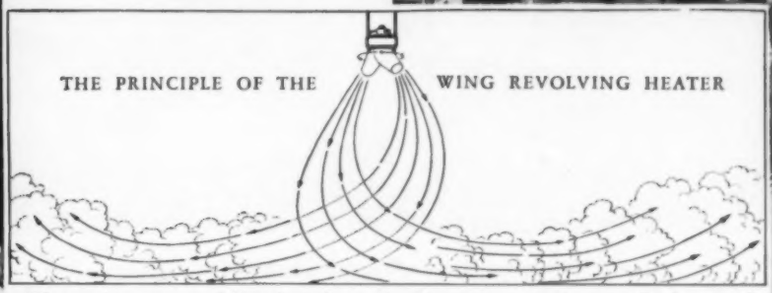
The new laboratory will be located at Koppers South Baltimore, Md., plant. Personnel and operations of the new laboratory will be directed by John W. Pennington, manager of the division's technical department.

More than 50 engineers, technicians, draftsmen, mechanics, and machinists will staff the laboratory, which will supplement work currently carried on in an adjacent metallurgical and chemical development laboratory. Facilities of the new laboratory will make possible the completely coordinated design, production, and testing of new products and product adaptations for the metal products division.

Development work conducted here will be closely coordinated with that carried on by Koppers company-wide Research Center at Verona, Pa., near Pittsburgh.

HEAT THAT MOVES AROUND

THE fact that the discharge outlets of WING Revolving Unit Heaters keep the heated air in constant, gentle motion is one of the reasons why nationally known firms like the Budd Company have installed them in their plants, both at Philadelphia and in the one shown in this photograph, at Gary, Indiana. The big blanking and forming presses in this great plant present a natural barrier to ordinary fixed discharge heating systems, but not to the moving streams of heated air from the WING Revolving Heaters, even suspended, as they must be, far above the floor, to clear the cranes. That is equally true in the summer time when, with steam turned off, the cooling breezes from the revolving discharge outlets keep workers comfortable on the hottest days. Investigate. Write for Bulletin HR-6.

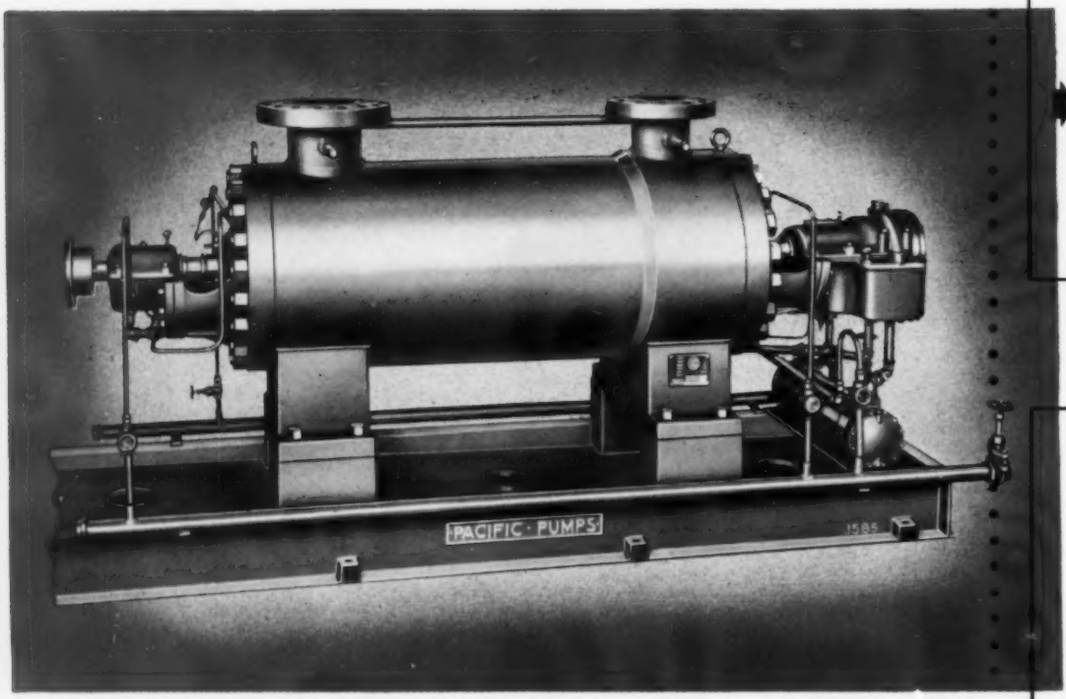


The moving streams of heated air (or cooling breezes in summer) sweep slowly around through 360 degrees, covering successively every direction. The air velocity is sufficient to carry to walls, and remote corners and the constantly changing direction of flow causes the air to find its way around obstructions.

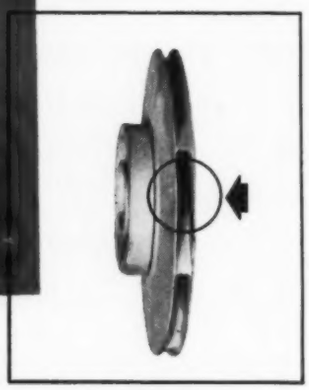
Wing

L. J. Wing Mfg. Co.
142 Vreeland Mills Road
Linden, New Jersey
Factories: Linden, N.J. and Montreal, Can.
In Europe: Etab. WANSON, Brussels, Belgium

What will Pacific CENTRIFUGAL PUMPS *do for you?*



THE NEW
New impeller ready for installation.



THE WORN
Impeller after 11 years' service.

● *They will last and last . . . give you years of trouble free service!* Pacifics are built in types to meet your requirements . . . they will deliver up to 2700 gallons per minute of cold or hot water at discharge pressures up to 3000 pounds per square inch.

Their strength and toughness is created by using carbon and alloy steels. The bearings for multi-stage pumps are pressure lubricated. Bearings for all types are sealed against dust and dirt. The result is less down time, fewer replacements and much longer pump life. Pacific Pumps *set new service records*—time after time.

PACIFIC *Precision Built* PUMPS

Pacific Pumps Inc.
ONE OF THE DRESSER INDUSTRIES

HUNTINGTON PARK, CALIFORNIA
Export Office: Chanin Bldg., 122 E. 42nd St., New York—

15-1

Physical attributes of the new laboratory will consist of a research library; a drafting room; offices for administrative personnel; electrical, mechanical, electronics and instrument, and dynamometer laboratories; and a large machine shop and test area.

PURCHASES TRACT ALONG OHIO RIVER

▲ Dravo Corp., Pittsburgh, Pa., has purchased a tract of approximately 60 acres along the Ohio River at Leetsdale, Pa., for possible future use in expanding its facilities.

The land, now vacant, fronts about 1900 ft on the Ohio River, and once was used by another firm for launching river craft. Purchase price was reported to be $175,000.

Dravo Corp.'s shipyard and main plant are located on Neville Island in the Ohio River four miles upstream from the new property and nine miles downstream from Pittsburgh's Golden Triangle. Major activities there include construction of towboats, barges and other shipbuilding and repair work; construction of heavy material handling equipment; manufacture of industrial heating units, and river sand and gravel supply.

CLARIFIES STATEMENT ON TIN MILL ADDITION

▲ In response to inquiries concerning his reference in a recent year-end statement to installation of a third electrolytic tinning line at the Fairfield Tin Mill, Arthur V. Wiebel, president of the Tennessee Coal & Iron Division of the United States Steel Corp., made the following statement:

"The Tennessee Coal & Iron Division has now placed substantially all of the contracts pertaining to this improvement of facilities at the Fairfield Tin Mill and preliminary work in connection with this installation has begun. It will require approximately a year to complete the installation and get it into production.

"This electrolytic line will permit production flexibility to meet the ever-changing requirements of the can-making industry of the South. Its functions will result in replacement to some extent of equipment now in use at the Fairfield Tin Mill."

now even better

SKF Triple-Seal "SAF" PILLOW BLOCKS

BETTER Because SKF's Type "C" Spherical Roller Bearings . . . .

Increase capacity 25% to 50%
increase service life 2 to 3½ times

The big news in bearings—news from SKF—is the Type "C" Spherical Roller Bearing—as a replacement for ordinary sphericals, size for size, lasts *2 to 3½ times longer, increases capacity up to 50%*.

This improved design is now available in SKF's famous Triple-Seal "SAF" Pillow Blocks.

You get this longer life and increased capacity *in addition* to—

- Effective sealing from dirt.
- Lubricant retention.
- Adapter mounting for tight fits on standard shafting.
- "Free" or "Held" design.
- Easy installation and inspection.
- Self-alignment.
- NO INCREASE IN COST!

YOUR SKF DISTRIBUTOR will give you complete details about the "C" bearing and a copy of SKF Bulletin No. 365 which contains technical data, sizes available, increased life and capacity you can expect for each size.

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
—*manufacturers of* SKF *and* HESS-BRIGHT *bearings.*

7521

SKF®
BEARINGS AND PILLOW BLOCKS

CONTINUOUS OPERATION at any speed

RELIANCE V★S DRIVE ®

with

the new

Totally-Enclosed Dual-Cooled

PATENT APPLIED FOR

motor

For continuous operation over extremely wide speed ranges . . . or wherever unusually severe operating conditions must be met . . . the new Reliance Totally-Enclosed Dual-Cooled Motor extends the application range of the V★S Drive. Wherever high ambient temperatures, intermittent operation, prolonged low-speed operation, or severe duty cycles pose difficult cooling problems, Reliance V★S Drive with Dual-Cooled Motors have proved to be the best answer. The new Dual-Cooled Motor is available either totally-enclosed or explosion-proof, conforming to Bureau of Mines and Underwriters' specifications, in ratings from 15 through 150 hp. D-1464

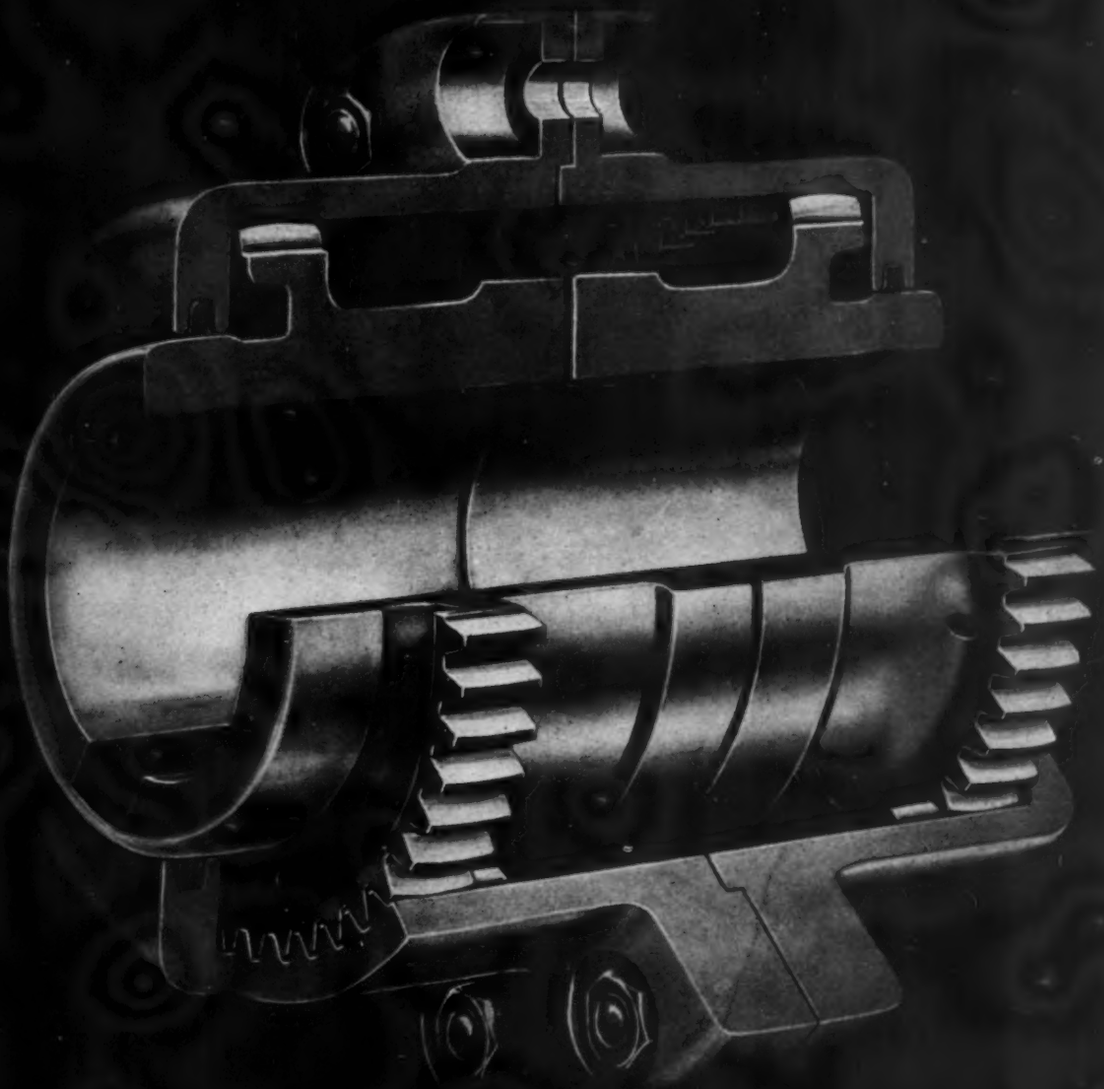
GET THESE FACTS NOW!

Your request for Bulletin C-2201 will bring you this new booklet featuring large cutaway drawing with 3-color transparent overlay showing operation of Reliance Dual-Cooled Motor, together with fact-filled bulletin showing production increases and operating economies obtainable with Reliance V★S Drive.

RELIANCE ELECTRIC AND ENGINEERING CO.

1084 Ivanhoe Road, Cleveland 10, Ohio • *Sales Representatives in Principal Cities*

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

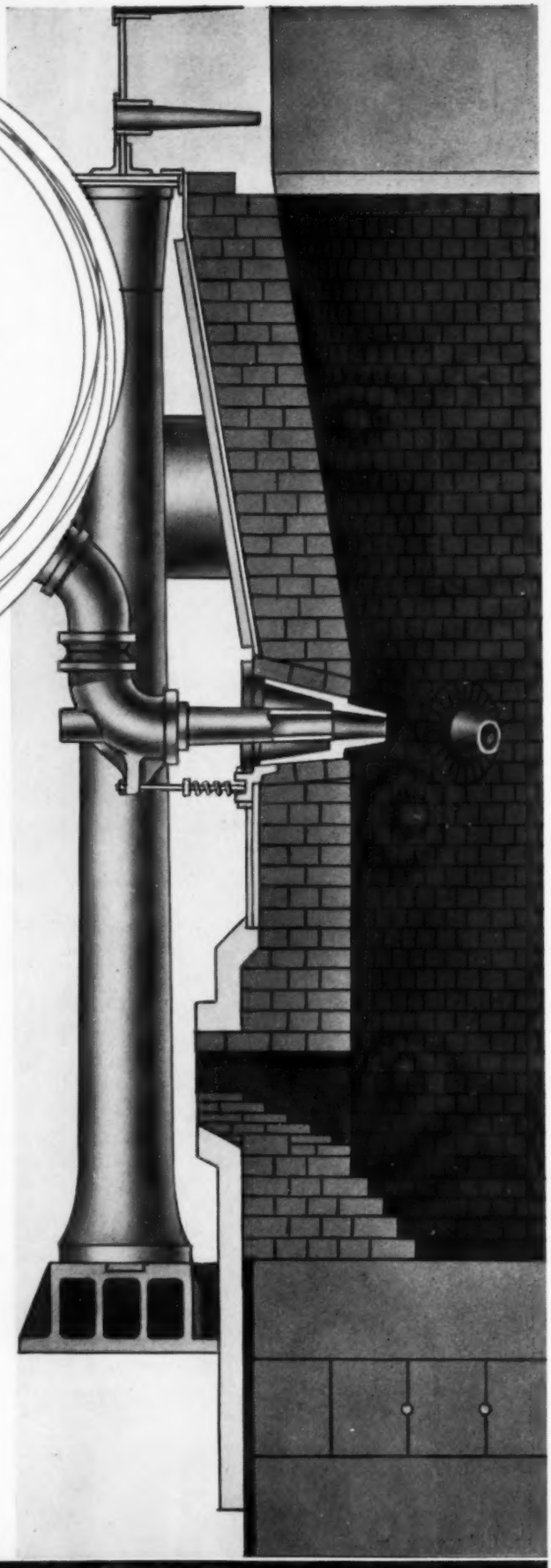
WOODBERRY, BALTIMORE, MD.

SAVE ALL THE WAY WITH

NATIONAL

TRADE-MARK

CARBON BLAST FURNACE LININGS



Record operating economies — so outstandingly established by "National" carbon in blast furnace hearths—*needn't stop there!* Now you can get the same advantages — longer life, lower maintenance, smoother operation—with carbon linings in blast furnace walls, in tuyere and in bosch sections.

Present day economics indicate now, more than ever, a need for carbon "all the way". Let's talk it over in terms of *your* operation!

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

OTHER* NATIONAL CARBON *PRODUCTS:

ELECTRIC FURNACE ELECTRODES · CARBON BRICK AND RAMMING PASTE · TROUGH LINERS · MOLDS AND MOLD PLUGS · SKIMMER BLOCKS · SPLASH PLATES · TANK LININGS AND HEATERS · HEAT EXCHANGERS AND PUMPS · BRUSHES FOR MOTORS AND GENERATORS

Personnel News...

Frank A. Mesta was elected executive vice president and treasurer of Mesta Machine Co. **John D. Iversen** was elected vice president in charge of operations and a member of the board of directors. Mr. Mesta, who succeeds his brother, the late **Lewis W. Mesta** who died December 30, began his career with the company in 1916, and since that time has served in various departments of the company. He was elected assistant treasurer in 1931 and vice president and treasurer in 1932. He has been a member of the board of directors since 1930. Mr. Mesta is a nephew of **George Mesta,** founder of the Company. Mr. Iversen started in the engineering department in 1935 and has served in various capacities in the company. He was appointed general superintendent in January 1952.

C. P. Mayer has been appointed manager of roll sales of the Mesta Machine Co., Pittsburgh, Pa. Prior to coming to Mesta, he was associated with his father in The Mayer Industries. Mr. Mayer has been with Mesta for the past eleven years.

Lyle F. Gulley has been appointed works manager of the Granite City Steel Co. Mr. Gulley will supervise the blast furnace department, all steel works operating and service departments, steel works engineering and maintenance, the department of industrial and personnel relations, the production department, safety department and industrial engineering. In 1951, Mr. Gulley came to Granite City Steel as purchasing agent, becoming director of purchases in 1952, and, later, assistant to vice president in the same year.

Lambert A. Salender has been named superintendent of the newly formed strip pickling and cold reduction department of Armco Steel Corp. He joined Armco in 1911, and has been at the Ashland plant since 1924. All of his career has been spent in the rolling and finishing departments. **John D. Patterson,** who started with Armco in 1928, will succeed Mr. Salender as superintendent of the Ashland plant's east processing department. He formerly was works industrial engineer. **Hillard E. Miller** was appointed superintendent of the west processing department. Mr. Miller was superintendent of processing and shipping at the time of his promotion and has been with Armco since 1917. **H. Claire Rutledge,** former assistant supervisor of the production department, has been made superintendent of the shipping department at the Ashland division. He has had long experience in the production department and was a planner at the time of his promotion. He joined Armco in 1925. **Lewis K. Edwards** was named works industrial engineer. He joined Armco in 1934, and has been in the industrial engineering department since 1942. He was an industrial engineer at the time of his new appointment.

Evan W. McNeill was appointed vice-president in charge of the Ohio Seamless Tube Division of Copperweld Steel Co., Shelby, Ohio. Mr. McNeill has been associated with Ohio Seamless Tube since 1930. As vice-president, he succeeds **W. C. Connelly** who has directed Shelby operations since 1938. **Aaron W. Waines** will continue as manager of sales and **H. Clayton Mayer** as manager of production. Other promotions announced at the same time involve **Merle Hoffman** who has been appointed assistant secretary and division controller and **John Hoak** who has been made assistant treasurer.

John T. Seaman was appointed assistant division superintendent of power and fuel at Gary Steel Works of U. S. Steel Corp. He succeeds **Harold R. Middlebrook,** who retired on December 31. Mr. Seaman began his U. S. Steel Corp. service at Gary in September, 1940, as an expediter in the engineering department. Later he became supervisor of electrical construction. He was transferred to the post of assistant chief construction engineer in the Pittsburgh office in March, 1951, and in November, 1953, moved to Fairless Works as general foreman of the electric shop.

Merlyn G. Woodle was appointed superintendent of Republic Steel Corp. Minnesota ore mines. Mr. Woodle succeeds **J. H. Hocking,** who died recently. In his new capacity, Mr. Woodle will be in charge of the mining operations of Republic's Susquehanna, Stevenson and St. Paul mines. In March, 1945, he was first employed by Republic as pit foreman and was promoted to as-

FRANK A. MESTA

JOHN D. IVERSEN

C. P. MAYER

LYLE F. GULLEY

sistant superintendent of the Minnesota mines on May 1, 1947. He recently returned from Liberia, West Africa, where he was temporarily employed as acting manager of the mining operations of Liberia Mining Company, Ltd.

A. R. Edwards has been elected president of Armco International Corp. Mr. Edwards had been vice president in charge of sales for Armco International. He has had 30 years of experience in world trade with the company, and at one time was in charge of Armco Inter-

A. R. EDWARDS

national's London office. He succeeds **E. A. Emerson**, who had been president of Armco International since 1931, and has been elected chairman of the executive committee of the company.

Ralph R. Flynn retired as traffic manager for Inland Steel Co. on December 31, after more than 41 years' service with the company. He was succeeded by **Elliott C. Youngberg**, who has been assistant traffic manager. Mr. Flynn began his career with Inland in 1912 as a demurrage supervisor in the railroad yard at the company's Indiana Harbor Ind. Works. He became assistant traffic manager in 1925, and ten years later was made traffic manager. Mr. Youngberg, who joined Inland in 1940, was named assistant traffic manager two years ago after serving as manager of business procedures and as acting head of the administrative divisions of the company's sales department.

L. J. Johnson has been appointed general sales manager of Mathews Conveyer Co., Ellwood City, Pa. Mr. Johnson managed the field engineering office in New York, N. Y. for several years and recently returned to the home office at Ellwood City, assuming the position of assistant sales manager until his present appointment.

H. A. Harrington has been appointed to the newly created position of assistant general manager, Leschen Wire Rope Division, H. K. Porter Co., Inc., St. Louis, Mo. Mr. Harrington, will assist in the overall management of the division.

W. J. Ulrich, Carborundum Co. senior sales representative in the Detroit area was elected vice president of the company. Mr. Ulrich will continue his sales activities in the Detroit area, however, he will report to the vice president of sales in Niagara Falls, N. Y. **F. W. Bonacker** was elected assistant vice president in charge of sales for Carborundum's bonded products and grain division. Other appointments to Niagara Falls posts in the bonded products and grain division were: **W. J. Kingsley**, sales manager for industrial product lines; and **J. G. Fritzinger**, sales manager for special accounts. Appointments to headquarters posts of the coated products division in Wheatfield, New York, were: **John F. Claydon**, director of the industrial sales branch; and **H. P. Dales**, industrial sales manager. The New York and Philadelphia sales districts were combined into a new sales district designated the Middle Atlantic sales district, with **J. A. Decker** as district sales manager. Other district sales managers appointed were: **W. D. Dickerson** for the Detroit district; and **H. C. Smith**, St. Louis district sales manager.

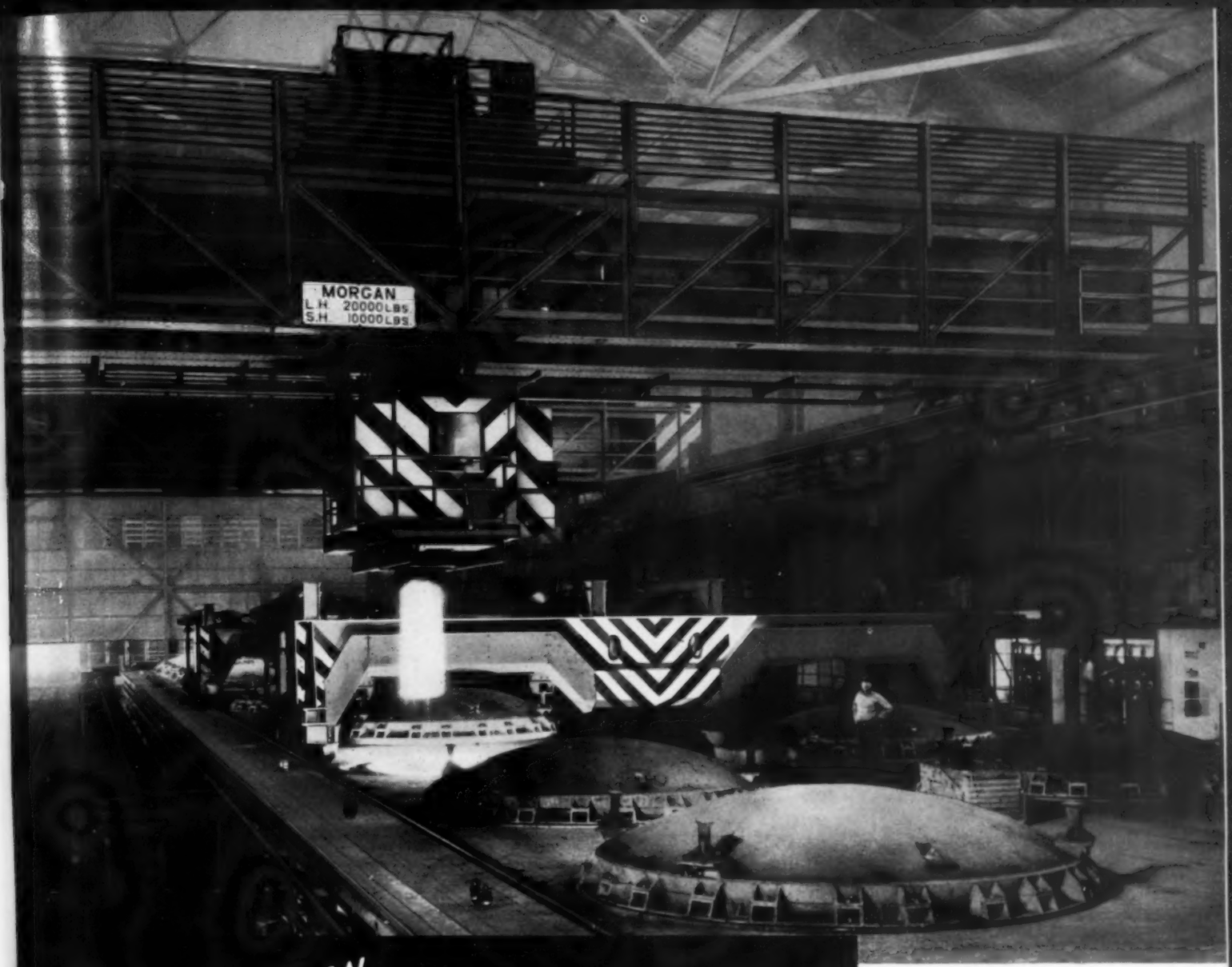
A. W. Bridges and **L. W. Kutz**, application engineers, were appointed to the Philadelphia district sales office of Reliance Electric & Engineering Co., Cleveland, Ohio. Other appointments include **C. A. Emmert**, Baltimore, Md., branch sales office; **James W. Landers**, Newark, N. J. branch sales office; **William M. Morris, Jr.**, New Haven, Conn. branch sales office; **William J. Constandse**, Cincinnati, Ohio district sales office.

William R. Hough, engineering vice president of Reliance Electric & Engineering Co., Cleveland, Ohio was elected a director of the company. The company's present nine directors were re-elected, and a regulation limiting the number of directors to nine was removed

WILLIAM R. HOUGH

permitting the election of Mr. Hough to the board. Mr. Hough joined Reliance in 1929, successively holding several positions in the engineering organization which led to his election as engineering vice president in 1948.

S. H. Smith, district manager of Air Reduction Sales Co. Milwaukee office, retired January 1, 1954, under the company's mandatory retirement plan, after 38



BUILT BY MORGAN *Engineering*

MORGAN CRANES AT PUEBLO

Illustrated is one of two Morgan 10-ton, 7-motor, 94'5" span Soaking Pit Cranes at The Colorado Fuel & Iron Corporation's Pueblo Works. These cranes have a tongs range of 15"-30". All motions on trolley are through worm reduction units. The trolley frame, bridge trucks and ram are fabricated and welded into one-piece units.

Morgan has followed very closely the development of soaking pit cranes from the first tower and rack type to the present modern low stiff leg type built with or without counter-weights. Send for Bulletin 32-A.

THE MORGAN *Engineering* CO.

ALLIANCE, OHIO • PITTSBURGH — 1420 OLIVER BUILDING

DESIGNERS
MANUFACTURERS
CONTRACTORS

BLOOMING MILLS

PLATE MILLS

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ELECTRIC TRAVELING CRANES

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STEAM HAMMERS

STEAM HYDRAULIC FORGING PRESSES

SPECIAL MACHINERY FOR STEEL MILLS

In electrical installations *where QUALITY counts* use CONDULETS*

Quality does count in practically every electrical conduit installation that you make. When you use CONDULETS you know that you are putting in electrical equipment of the highest quality, because CONDULETS have been doubly tested . . . in the factory and in the field.

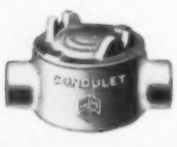
Crouse-Hinds quality control assures a long-lasting product and field records prove it by the test that only time can give. Thousands of CONDULET installations are still in tip-top condition after twenty, thirty, or even more than forty years of dependable service.

The illustration at the right shows four of Crouse-Hinds' basic quality features that are common to all CONDULETS. The fifth, Wedge Nut Fasteners, is an exclusive Crouse-Hinds feature that has made Obround CONDULETS preferred by electricians everywhere.

Type EVA Explosion-Proof Lighting Fixture

Type ARE Arktite Receptacle Equipment

Type FS Condulet With Pilot Lamp Receptacle, Switch and Plug Receptacle



Type GUAC Explosion-Proof Junction Condulet

1. **Taper tapping.** Condulet threads are taper tapped to match tapered conduit threading. Makes a rigid joint that will not loosen. This assures permanent ground continuity . . . important for safety.
2. **Integral bushing.** A smooth rounded surface protects wire insulation.
3. **Material.** Feraloy . . . a special alloy that is strong and tough, resists corrosion, and gives sharp, full threads
4. **Finish.** A triple treatment provides long-lasting protection . . . exceeds Federal and U. L. specifications.
5. **Wedge Nut cover fastener.** Clear cover opening . . . no projections. No loose parts . . . Wedge Nuts and screws self-retained. No screw holes to align.

More than 15000 items are listed in the Condulet Catalog including a complete explosion-proof and dust-tight line for use in hazardous locations.

On your next job, use CONDULETS . . . they're made right to last longer.

**CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.*

Type VC Vaportight Industrial Lighting Fixture

Type FLF Explosion-Proof Manual Motor Starting Switch Condulet

Type EPC Explosion-Proof Motor Starter and Circuit Breaker Condulet

A Nationwide Distribution Through Electrical Wholesalers

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Syracuse 1, N. Y.

OFFICES: Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland — Dallas — Denver — Detroit — Houston Indianapolis — Kansas City — Los Angles — Milwaukee — Minneapolis — New Orleans — New York — Philadelphia Pittsburgh — Portland, Ore. — San Francisco — Seattle — St. Louis — Tulsa — Washington.
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CONDULETS · TRAFFIC SIGNALS · AIRPORT LIGHTING · FLOODLIGHTS

years service in the oxyacetylene industry. **G. J. Dekker,** formerly district manager of St. Louis, succeeds Mr. Smith as district manager in Milwaukee, effective January 1, 1954. Mr. Dekker, who has been with the company for 35 years, has held managerial positions in Chicago, Cleveland, Detroit, Oklahoma City, Madison, Wis., and New York.

Joseph H. Carter has resigned as chairman of the board and as a director of Pittsburgh Steel Co. At the

JOSEPH H. CARTER

request of the board of directors, Mr. Carter has agreed to remain with the company as a consultant. **Avery C. Adams** will assume the duties of chairman of the board

ALLISON R. MAXWELL, JR.

in his capacity as president of the company. **Allison R. Maxwell, Jr.,** vice president of sales, has been elected to the board of directors.

Grover C. Ruth was appointed superintendent of the masonry department of Republic Steel Corp., Youngstown, Ohio steel plant. Mr. Ruth, a member of the third generation in his family associated with the steel industry, formerly was general masonry foreman at Republic's Cleveland steel plant.

Harold C. Sproul was appointed district sales engineer of Hydropress, Inc., covering Michigan, Wisconsin and the northern parts of Illinois, Indiana and Ohio, with headquarters at Chicago, Ill., and Detroit, Mich.

George W. Alexander was appointed assistant to the operations manager of Dravo Corp. engineering works division.

J. P. Craven has been named superintendent of the erection department of Babcock & Wilcox Co. boiler division. Since 1946, Mr. Craven has been assistant superintendent of erection for the boiler division.

Glenn J. Gibson has been appointed to the engineering staff of Cooper Alloy Foundry Co., Hillside, N. J. Mr. Gibson will direct a research program aimed at developing superior methods for the welding of corrosion and heat resistant alloys. He has been with Air Reduction as a research engineer for the past nine years.

Willard W. Myers has been appointed superintendent of production planning of U. S. Steel Corp., Duquesne,

WILLARD W. MYERS

Pa., works. He was formerly assistant superintendent of production planning at McDonald works of U. S. Steel Corp., in Youngstown, Ohio.

Edgar L. Schultz was appointed sales manager for P. W. Voss and Associates, Chicago franchise representative of the Automatic Transportation Co. For the past year, Mr. Schultz has served as a salesman, and as supervisor of the firm's industrial power sweeper division.

Martin W. Chandler has been appointed head of the architectural department of Kuljian Corp., engineers and constructors, Philadelphia, Pa.

Harry "Buck" Freeman, one of the seven original employees of Square D Co. when it started in business in a rented Detroit, Mich., loft building 50 years ago, was guest of honor at the annual "Oldtimers dinner" of the company held at the Park Shelton Hotel. Mr. Freeman, still actively working for the company as an engineering consultant on special projects, was inducted into the 50-year employee class by vice president **L. W.**

Mercer. First and only member of that half-century group, Mr. Freeman started his career with Square D when the firm was known as the McBride Manufacturing Co. In 1917 the company changed its name to Square D and concentrated on electrical distribution and control equipment instead of fuse making.

Evon W. Holbrook, superintendent of stores at Kaiser Steel Corp., Fontana, Calif., has been appointed assistant to the purchasing agent. Mr. Holbrook's place will be taken by Merton E. Wade, his assistant. Mr. Holbrook joined Kaiser Steel in January 1944 as assistant equipment supervisor; later he was assigned to the

EVON W. HOLBROOK

stores department where he was made foreman in 1946. After a period as assistant storekeeper, he became a buyer in the purchasing department and subsequently assistant superintendent of stores, then superintendent.

John C. Ketterer has been named assistant superintendent of operations at the Midland, Pa., plant of Mackintosh-Hemphill Co., Pittsburgh, Pa. Wilson J. Rhodes, formerly assistant manager of production succeeds Mr. Ketterer as manager of production at the Midland Plant.

Prof. Loyal V. Bewley, head of the department of electrical engineering at Lehigh University, was named dean of the college of engineering by the Lehigh University board of trustees. A member of the faculty since 1940, he has served as secretary of the Lehigh University engineering executive committee for the past two years. Before joining the Lehigh staff, he served as research engineer of the General Electric Co. for 17 years.

F. Gordon Ricker was appointed assistant to the general sales manager, materials handling division of Yale & Towne Manufacturing Co., Philadelphia, Pa. Mr. Ricker, for the past seventeen years, has been branch manager of the Pittsburgh division. Succeeding Mr. Ricker as Pittsburgh branch manager, will be Robert B. Coleman, formerly sales manager of the Cleveland branch.

A. E. "Andy" Milner was appointed manager of arch and wall sales of Laclede-Christy Co. Mr. Milner has a background of diversified engineering experience. He began work in the steel mills in Youngstown-Pittsburgh district, a few years after leaving high school. He was structural design engineer for Smith, Hinchman and Grylls, Inc., an architect-engineering firm in Detroit, Michigan. Later he became architect superintendent for Eberle M. Smith and Associates of Detroit. Subsequently, he became chief structural engineer for Granco Steel Products Co., Granite City, Ill., and was thereafter elected manager of their Cofar division.

Theodore A. Haschke has been appointed director of sales of the newly-organized industrial chemical division of Stauffer Chemical Co., its subsidiaries and associated companies. Mr. Haschke started in the chemical business in 1919 and joined Stauffer seven years later. He was named sales manager of the eastern division in 1942, a post he held until this latest promotion.

John A. Faas was appointed chief mechanical engineer of Walter Kidde Constructors, Inc., engineers and builders, New York and Houston. Associated with The H. K. Ferguson Co. for 14 years, Mr. Faas is a specialist in the design and construction of chemical processing plants. He has had extensive experience in the design of oxygen plants, fatty alcohol facilities, high pressure hydrogenation plants, edible oil processing facilities, synthetic detergent plants and facilities for hydrolysis of fatty acids.

Merton E. Wade has been named superintendent of stores at Kaiser Steel, where he has previously served as assistant to Evon W. Holbrook, who has been pro-

MERTON E. WADE

moted. Mr. Wade has been associated with the steel company since 1951, when he entered the company's industrial engineering department.

W. S. Truesdell has been appointed general manager, Buffalo Steel Division, H. K. Porter Co., Inc., Tonawanda, N. Y. Mr. Truesdell, with Buffalo Steel for 23 years, succeeds A. E. Klinger who has been made vice president in charge of commercial development. In his

Announcing– the new LPD design **Clipper Oil Seal**

The design of the new LPD Clipper Seal assures that the spring which controls the lip contact on the shaft will be held tightly in the seal. It further provides a husky lip section that enables better control of lip flexing, and better utilization of the full available depth of the lip section.

. . . with reinforced heel developed especially for equipment used by the iron and steel industry

HERE IS THE newly designed Type LPD Clipper Oil Seal that lasts longer and seals more effectively than any previous design. It runs cool, sealing tightly even when shaft speeds are higher and equipment variables wide.

The new Type LPD Clipper Oil Seal can be supplied with the special reinforced heel developed to withstand the severe jolting of back-up roll bearing service. Thoroughly field tested, this special Clipper Seal is now being used with unusual success on hot and cold rolling mills, finishing trains, rod mills, wire mills and similar equipment.

The longer life of this new Clipper Seal lessens replacements. It lasts longer and withstands higher shaft speeds because it requires less lubrication over its lip bearing area. Furthermore, the LPD design provides better utilization of the lip section of the seal—another factor in prolonging its life. And the greater flexibility of this lip section improves the performance of the seal.

• • •

For more information about the new Type LPD Clipper Seal with special reinforced heel, write Johns-Manville, Box 60, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS **Johns-Manville CLIPPER SEALS**

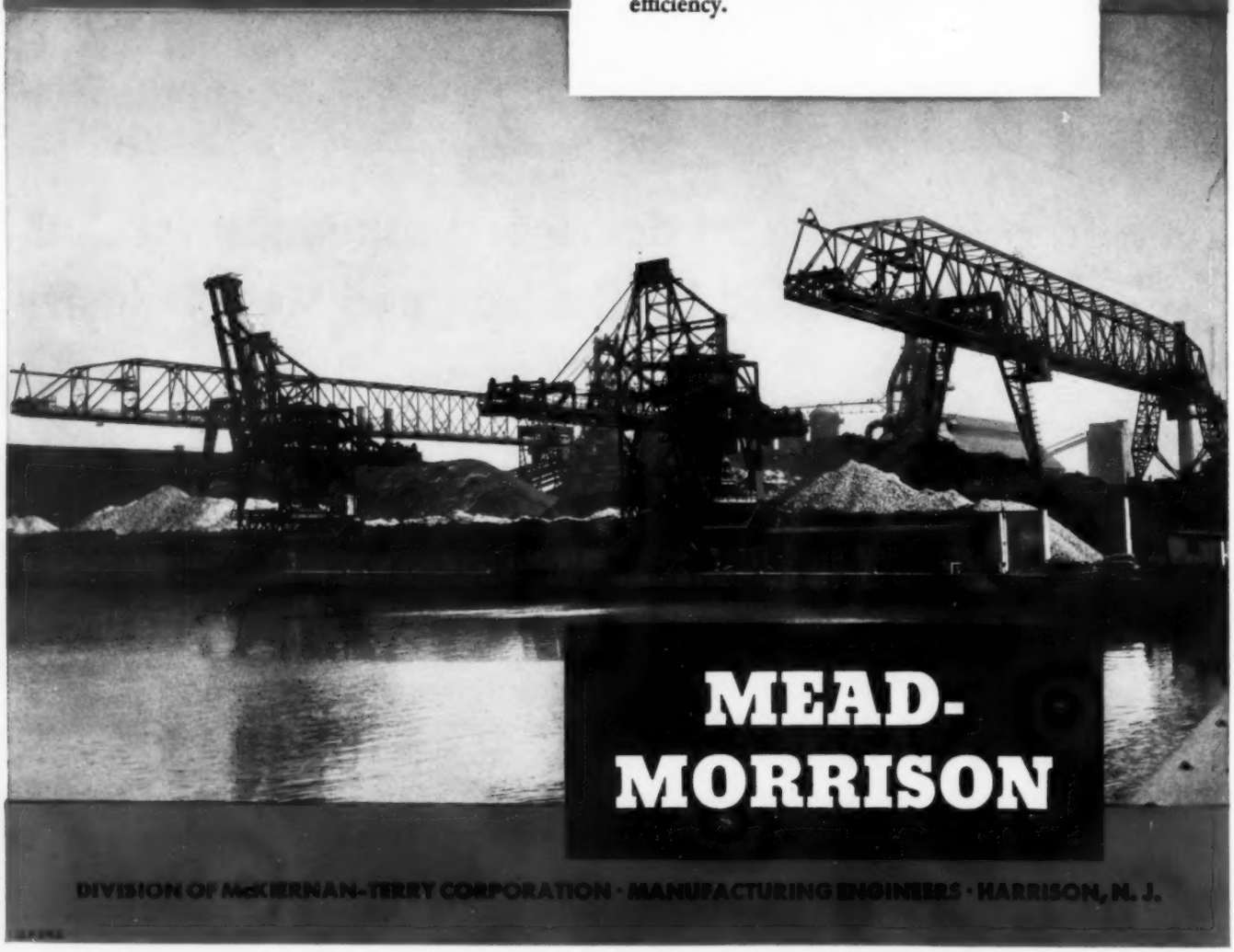
all set for speedy material handling

This team of two Unloaders and two Bridges are part of the Mead-Morrison material-handling equipment at a large midwestern steel mill.

Each of the structures and their equipment has a capacity of 12 tons and is of the man-trolley type. The unloaders discharge ore or limestone from lake steamers, and deposit it in the trough, from which it is rehandled by the bridges to storage piles and to the high line feeding the blast furnaces.

Additional Mead-Morrison Bridges and Unloaders are also operating in the coal storage yard of this same steel company.

If you need new unloading facilities or increased capacity from your present equipment, the Mead-Morrison engineers will help you plan for greatest efficiency.



MEAD-MORRISON

DIVISION OF McKIERNAN-TERRY CORPORATION · MANUFACTURING ENGINEERS · HARRISON, N. J.

new position Mr. Truesdell will be in charge of all manufacturing and sales operations of this steel rolling mill. His background includes positions as salesman, general sales manager and, until his present promotion, assistant general manager at Buffalo Steel.

Matthew H. Conway was appointed mechanical engineer of Chandeysson Electric Co., St. Louis, Mo. During the past nine years, Mr. Conway has served as drafting supervisor and engineer for the company.

Richard H. Ewert has been appointed general sales manager of Illinois Gear and Machine Co., Chicago, Ill.

Carl D. Bowers was appointed assistant director of safety at Kaiser Steel Corp., Fontana, Calif. Mr. Bowers joined Kaiser Steel in April 1946 as safety inspector. He was appointed safety supervisor, rolling mills division, in January 1951. He started in safety and personnel work with the American Rolling Mills

CARL D. BOWERS

Co. at Butler, Pa., from 1928-30. Thereafter until 1943 he was associated with Great Lakes Steel Corp., becoming assistant personnel director. For six months during World War II, he was wage and salary administrator with Douglas Aircraft at Santa Monica, then returned to Great Lakes Steel for two years as safety inspector.

George B. Varner was named advertising manager of the Industrial Tools division of Kennametal, Inc., Latrobe, Pa. to succeed **Fred W. Pennington** who retires after heading the division's advertising activities for the last ten years.

Francis Thomas, vice president of Orinoco Mining Co., has been elected president of that U. S. Steel Corp. subsidiary. Mr. Thomas succeeds **Mack C. Lake,** internationally-known mining engineer and geologist who supervised the post-war development of U. S. Steel's iron ore deposits at Cerro Bolivar, Venezuela. Mr. Lake will continue with United States Steel in a consulting capacity. Mr. Thomas wes elected a vice president of Orinoco in July, 1950, coming to the company from the

hot days will come again—
be prepared with . . .

LINTERN AIRE-RECTIFIERS

It is fast becoming standard practice to provide normal working temperatures by means of air conditioning throughout industry at the worst spots — wherever the handling of hot metal increases already excessive temperatures.

Outstanding among the advantages resulting from the use of Lintern Aire-Rectifiers for cranes and pulpits are increased production due to men working under normal, healthful conditions; improved personnel relations; reduction of wild cat work stoppages; elimination of relief men and premium rates. These savings soon equal the capital investment for an Aire-Rectifier.

Cab is air conditioned with Lintern Aire-Rectifier.

Since we have a complete line of models to meet all requirements — and priced according to capacities — the total investment for Lintern Aire-Rectifiers is the lowest consistent with good performance. *Maintenance is a minor item.*

May we suggest that you anticipate your requirements and order now so as to be prepared for the hot weather that is sure to come, thereby benefiting by: (1) delivery in ample time to maintain a high level of production regardless of the heat and (2) installation before the rush season with its increased costs.

THE LINTERN CORPORATION
ROUTE 20, EAST • PAINESVILLE, OHIO

Minneapolis contracting and engineering firm of S. J. Groves and Sons, where he was a vice president.

Robert W. O'Neal has joined Rees Machinery Co., Inc., Pittsburgh, Pa. as a sales engineer. Mr. O'Neal was associated with the United States Steel Corp. in the Chicago, Ill., and Pittsburgh, Pa., districts from 1933 to 1943, and with Follansbee Steel Corp. where he was employed as chief industrial engineer.

G. H. Hille was named director of purchases for Salem-Brosius, Inc., with headquarters at the company's general offices in Salem, Ohio. Mr. Hille, formerly with the purchasing division of Ladish Co., Cudahy, Wisc., will supervise all purchasing functions of the company.

T. F. McKenna has retired as St. Louis, Mo., sales representative of Electric Service Manufacturing Co. This sales area is now being handled by **W. E. Erbe** from a newly located district office, 4378 Lindell Boulevard, St. Louis, Mo.

F. Lee Davis was appointed manager of industrial sales of Pyle-National Co. of Chicago, Ill. Mr. Davis formerly was Detroit, Mich., district representative of

F. LEE DAVIS

the Benjamin Electric Manufacturing Co. **Frank M. Currie,** formerly manager of industrial sales for Pyle-National Co., has been appointed to the position of supervisor of field sales.

Kempton Dunn, first vice president of American Brake Shoe Co. was elected president of the company. **Maurice N. Trainer,** president since 1950, was appointed to the newly created post of vice-chairman. Mr. Dunn, a native of Philadelphia, has been with the company since 1932. Mr. Trainer joined the company in 1916 and moved up through the sales department.

Beresford N. Clarke has been assigned to the Ft. Wayne office of Surface Combustion Corp., and **Hugh W. McIntyre** has been appointed to the Detroit Industrial sales office of the corporation. Mr. Clarke has been engaged in development, service, and sales engineering work. For the past year he has been in the Quincy, Mass. office of the company. Mr. McIntyre has been associated with Surface Combustion Corp. since 1947.

BERESFORD N. CLARKE

He has worked in the development laboratories, field erection, and service departments of the company. He will specialize in sales engineering work in the Detroit office.

Wilson D. Trueblood, Jr., formerly in the Leeds & Northrup Co. Chicago, Ill., office, becomes district manager of their new office at 828 North Broadway, Milwaukee, Wisc., which will serve all of Wisconsin and Minnesota, the northern peninsula of Michigan, North and South Dakota east of the Missouri River, and the Canadian provinces of Manitoba and western Ontario. **Edwin A. Yeo,** for sixteen years the firm's Cincinnati, Ohio, manager, becomes district manager at Pittsburgh, Pa. Mr. Yeo, who joined L & N in 1928, replaces the late **Harold S. Vecella,** long-time L & N sales executive there. **Willard H. Neu,** formerly a sales field engineer in the Leeds & Northrup Pittsburgh office, becomes district manager at Cincinnati.

George Shutak has been appointed to the sales engineering staff of the Cleveland-Youngstown office of Ramtite Co. Mr. Shutak, before joining the Ramtite Co., was active in the refractories field as well as various allied sales lines.

William A. Bauer was elected president of Baker-Raulang Co., and **Charles N. Sumwalt, Jr.,** was appointed as executive vice president. Mr. Bauer, who has been board chairman, becomes both chairman of the board and president as a result of the election. He succeeds as president **James W. Moran,** whose recent retirement was effective January first. Mr. Sumwalt formerly was vice president in charge of the company's eastern sales division.

W. A. Anderson has been appointed manager of operations, Pittsburgh and Graham plants of Pittsburgh Screw and Bolt Corp. He had been assistant manager

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of operations of the two plants since December 1, 1952. Mr. Anderson succeeds **Wallace W. Smith**, son of the late **Thomas W. Smith** who was a co-founder of Pittsburgh Screw and Bolt Co., predecessor of the present corporation. Mr. Smith, who has served with the Corporation since 1913, will remain with the corporation in an advisory capacity.

Ralph H. Garlick, has been appointed superintendent of Republic Steel Corp. docks in Cleveland, Ohio. Mr. Garlick, who has been with the corporation and predecessor companies for thirty years, succeeds **C. E. Van Syckle** who retired at the beginning of the year. Mr. Van Syckle is a veteran of 53 years service in the steel industry. He was employed for 16 years at U. S. Steel Corp., Conneaut, Ohio docks, later taking charge of dock operations for the Corrigan-McKinney Steel Co., now a part of Republic Steel Corp., at Cleveland.

Obituaries

Richard Harry Stevens, formerly chief engineer at Bethlehem Steel Corp., Sparrows Point, Md., died December 31, 1953. Mr. Stevens entered the machine shop of Edgar Thompson works as an apprentice in 1888. In 1891 he entered the drawing room of the same company at Homestead. In 1902 he was made chief engineer there, a position he held until he became chief engineer of the Midvale Steel and Ordnance Co. in Philadelphia, Pa., in 1915. He retained this position with the exception of one year, when he was works superintendent at the Coatesville, Pa. plant of Midvale interests. Upon acquisition of Midvale properties by Bethlehem Steel Corp. in 1923, Mr. Stevens was appointed chief engineer of the Johnstown, Pa. plant, moving to the Sparrows Point plant in 1929.

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Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio

What's your cylinder problem?

Big one: Anker-Holth Rotating Hydraulic Cylinder with 21" bore and 20" stroke, for 3000 psi. Little one: Anker-Holth Air Cylinder with 3" bore, 3" stroke.

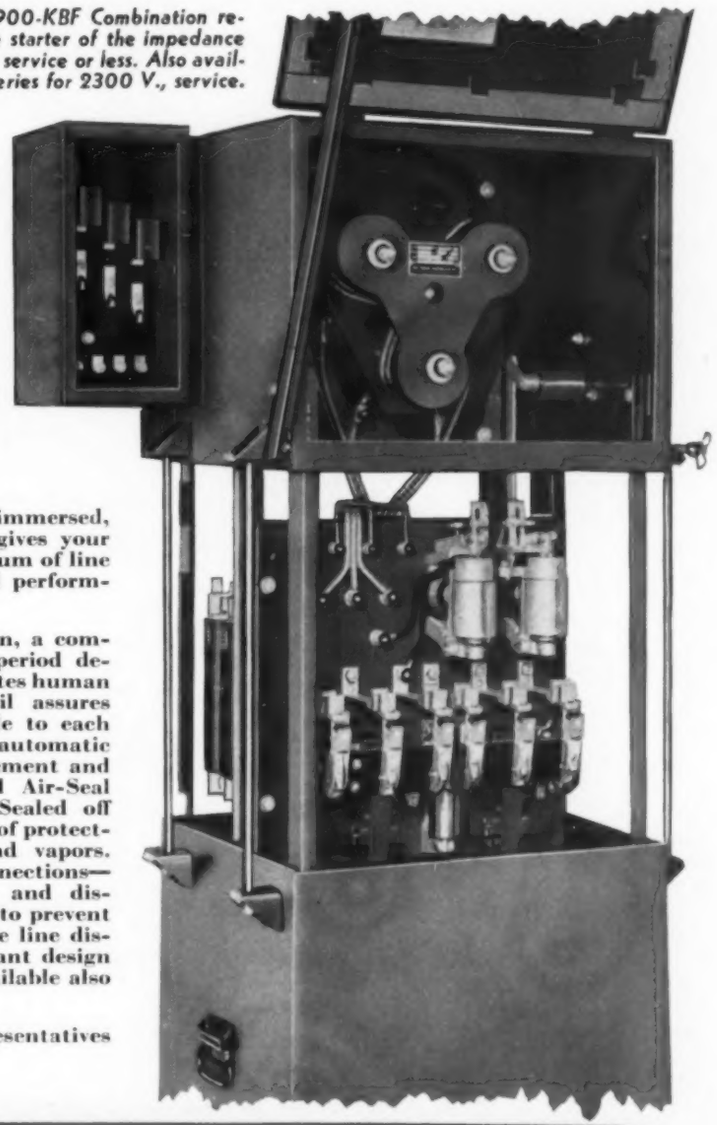
Anker-Holth has the answer!

• Your problem in power motion may be far removed from the Anker-Holth Cylinders shown above. Whatever your need for air or hydraulic cylinder power, Anker-Holth has the engineering know-how and manufacturing facilities to match your specific requirement. Anker-Holth engineers will gladly assist you. Call or write Anker-Holth Division of The Wellman Engineering Company, Dept. E-7, 2723 Conner Street. Port Huron, Michigan.

Anker-Holth
ENGINEERED CYLINDER POWER
WELLMAN
Division of THE WELLMAN ENGINEERING COMPANY

Oil Immersed

Rowan Type 900-KBF Combination reduced voltage starter of the impedance type, 600 V., service or less. Also available in 950 series for 2300 V., service.



ROWAN
Type 900 Series
REDUCED VOLTAGE STARTER

Push button operated—fully automatic—this oil immersed, reduced voltage starter of the impedance type gives your induction motors a smo-o-oth start with a minimum of line disturbance. Check its design, construction, and performance features:

√ Closed transition type—utilizes for acceleration, a combination of current and time. √ Acceleration period dependent upon driven equipment and load—eliminates human element. √ Continuous wound impedance coil assures freedom from tap failures—impedance adjustable to each application. √ Magnetic overload relays with automatic reset—provides a combination of inverse time element and instantaneous operation. √ Rowan time-tested Air-Seal fuses—dependable short circuit protection. √ Sealed off centralized wiring compartment—eliminates need of protecting incoming and outgoing leads from oil and vapors. √Provision for straight through conduit connections—facilitates installation and inspection. √Tank and disconnect mechanism is mechanically interlocked—to prevent the lowering of the tank before disconnecting the line disconnect switch. √ Enclosure is of weather-resistant design to meet the requirements of NEMA Type XI—available also for Class I Group D locations.

Complete information available from Rowan representatives in principal cities of the United States.

ROWAN CONTROL

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Tube Mill Practice

A selection of articles
from the
IRON AND STEEL ENGINEER
on various phases of
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Practical information on layout and operation of facilities for seamless, butt and electric weld pipe, a field in which little information has been published . . . 23 articles by 20 authoritative writers . . . invaluable for engineers, operators, trainees and students.

8-¼ x 11-¼ in., ... 196 pages, illustrated, clothbound

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FEBRUARY, 1954

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(1) Dust Collector

A bulletin has been made available by the American Air Filter Co., describing the newly developed AMERjet dust collector. This is a reverse jet fabric collector designed for those applications where extremely fine particles are involved or where the material must be collected in a dry state for reclaiming. The cleaning media is automatically reconditioned by a jet of high pressure air forced through the cloth in opposite direction to the flow of the air being cleaned. Because the cleaning cycle is continuous, the AMERjet maintains a constant pressure drop and thus a steady air volume at the exhaust points. This method of media reconditioning also permits much higher velocities through the cleaning tubes. Therefore, less filter cloth is needed for any given cfm than is required by conventional cloth envelope or bag type collectors. The size of the dust collectors needed is thus materially reduced. (Bulletin 279)

(2) Thermocouples and Accessories

A new edition of its 36-page bulletin, "Thermocouples and Accessories," has just been issued by the Foxboro Co. Listed, with specifications, are standard thermocouples for all applicable temperature ranges. Separate sections are devoted to the tubular-type iron-constantan couples, wire-type iron-constantan and copper-constantan couples, and chromel-alumel alloy and platinum couples. Generously illustrated, the bulletin contains dimensional drawings of complete assemblies. Ten installation diagrams are helpful in determining types of thermocouples needed for various furnaces, tanks, kilns and pipe lines. In addition to complete parts lists for each type, there are catalogued sections devoted to couple supplies and accessories, such as connection heads, protection tubes, flintex porcelain insulators, sheaths, stuffing boxes, extension wire and bulk thermocouple wire. (Bulletin 235-5)

(3) Instrumentation Data Sheet

Minneapolis-Honeywell Regulator Co. announces a new data sheet describing industrial instrumentation applications of the ohmart cell—the unique radioactive sensitive element which converts nuclear radiation directly into electrical energy. Used with a Brown Electrometer and a null balance type of measuring circuit, it permits extremely accurate measurement of film thickness, density, specific gravity, liquid-liquid interface level, density, concentration of alpha, beta, gamma or neutron radiation and the composition of binary gas systems. Complete descriptions of the ohmart cell models and the electrometer are included with application details. (Data Sheet 10.0-15)

(4) Design Booklet

The special products division of I-T-E Circuit Breaker Co. has made available a 20-page booklet that design engineers and methods engineers will want for information and reference. The booklet discusses radar antenna systems, their design, development and fabrication; jet engines, new fabrication methods for major components of engines; thermodynamics, design, development and fabrication of equipment to operate on advanced theories; guided missiles and new fabricating techniques for airframe members; titanium, the development of new welding, forging, forming and spinning techniques for this hard-to-work metal. The booklet also discusses automatic spinning and tells how by combining spinning with drawing, the design engineer can secure an almost limitless variety of designs in a wide range of metals. (SP-100)

(5) Shear and Slitter Knives

A handbook on shear knives and slitter knives has been published by the American Shear Knife Co. Purpose of the handbook is to provide a single source of basic information on the use and maintenance of shear knives and slitter knives. It is especially valuable to users in mills and in fabricating plants.

Among the subjects covered are grades of shear knives, recommended applications, shear knife tolerances, slitter knife tolerances, regrinding service, and other useful information. Suggestions are given for the proper care of knives, proper grinding procedures, and knife-setting recommendations.

(6) Flexible Conduit Fittings

The Adalet Manufacturing Co. offers a bulletin describing their line of flexible conduit and suitable end fittings which are available in sizes larger than previously available. Both 4 in. and 5 in. connectors are available. Additionally, both sizes of couplings, by means of which the flexible conduit is joined to rigid conduit, are available. All four fittings are of heavy duty construction, with four bolt clamps and ridges cast into the clamping member to engage the convolutions of the flexible conduit. (Bulletin 154)

(7) Vapor Barrier Book

Complete recommendations for vaporsealing insulation on low temperature vessels are given in an 80-page, volume just published by the Insul-Mastic Corp. of America. The book is entitled "Vapor and Weather Barriers for Low Temperature Installations." It illustrates exactly where and how a vaporseal coating should be applied over thermal insulation to prevent deterioration of the insulation, and rusting of the vessel beneath it due to moisture and moisture vapor. The manual covers the three major classes of insulation. It discusses and illustrates the vaporsealing of every chemical vessel detail from tanks and pipes to valves and flanges.

(8) Spot Welding Gun

A folder has just been produced

by Air Reduction Sales Co., covering in detail the features of the new "Aircospot" process and equipment. This inert gas-shielded spot welding gun which welds from one side only and without the need for back-up plates, is completely described with illustrations, physical and electrical specifications and operating data.

(9) Pre-Assembled Distribution Unit

A new bulletin entitled "The Power Pac Assembly—A New Type of Pre-Assembled Distribution Unit" has just been published by Pennsylvania Transformer Co. This booklet discusses in detail this new type of transformer assembly and shows how this pre-assembled, single tank unit, embodying standard distribution core-and-coil assemblies is suitable for single or multiple customer service. Complete with eight photographs of typical assemblies, as well as outline drawings of primary and secondary connections, the booklet includes drawings of typical vault installations as well as a cost analysis of vault installations. (8534)

(10) Flexible Couplings

Lovejoy Flexible Coupling Co. has made available a twenty-page catalog on flexible couplings. The publication features drawings of the various couplings, together with tables listing specifications and operating capacities for each. Also included are tables on varying or pulsating load conversion, and horsepower to torque conversion.

(11) Quick Break Interrupter

A new booklet just released by Delta-Star Electric Division, H. K. Porter Co., describes the company's new type "QB" device in various positions of operation on different types of air switches. Enlarged views from a movie film, taken at 190 frames per second during a field test, clearly illustrate the nature of the arc interruptions. Also shown are the results of an ice test with the switch closed and opened.

(12) Rolling Mill Equipment

A new 36-page bulletin which describes and illustrates its line of rolling mills, gear drives, pinion stands and rolling mill handling equipment is now available from Farrel-Birmingham Co., Inc. Included in the booklet are pictures of more than thirty sizes and types of mills for nonferrous rod, strip or sheet, metal foil and cold strip steel, plus illustrations of related equipment, all informatively captioned.

(13) More Work Out of Rope

Seventeen "life-saving" tips for improving wire rope service are given in a new folder offered by Leschen Wire Rope Division, H. K. Porter Co., entitled "How to Get More Work Out of Your Wire Rope." Suggestions for correct handling and storing, and recommendations for proper use of rope are included. Reading matter is brief but pertinent; folder is highly recommended for all wire rope users and equipment operators.

(14) Steel Castings Catalog

The American Manganese Steel Division of American Brake Shoe Co. has just released a new general catalog, describing their complete line of castings. Typical castings are shown in over 100 photographs with applications listed. There is also a complete discussion of the impact and abrasion resistant characteristics of Amsco 13 per cent manganese steel under each product category. Detailed information is included on power shovel dippers, teeth, chain, gears, sheaves, crusher parts, dredge and materials handling pumps, etc.

(15) Pulpit Air Conditioner

A bulletin recently published by Dravo Corp. describes a pulpit air conditioner designed and developed for use in industrial control areas where heat, dirt, or fumes create hazardous working conditions. The booklet lists all mechanical features of the conditioner, and presents tables of capacities and dimensions of the different evaporators and condenser sections available. (Bulletin 1307)

(16) Industrial Products Catalog

Johns-Manville Corp. has issued a new edition of its 40-page industrial products catalog which offers essential data on the following groups of products: insulations, refractory products, asbestos cement pipe, packings, gaskets, electrical products, frictional materials, roofing, siding, flooring, partitions, and ceilings. Photographs, diagrams, and text have been revised and brought up-to-date so that engineers and plant executives will have the latest information in a compact catalog that is easy to use.

(17) Bearing Selection

Basic technical data, facilitating selection of the proper bearings for any installation, feature a new catalog made available by Bantam Bearings Division, The Torrington Co. Particularly helpful to designers and engineers are numerous pages of cross-section drawings showing the details of typical installations, and a bearing recommendation sheet for indicating detailed requirements. The catalog data cover design features, bearing selection, sealing, and lubrication. Included are tables listing speed and life factors, as well as capacities, while hardness factors are conveniently charted. Dimensions of bearing assemblies, inner races and housing and shaft fits are presented. Various types of bearings are illustrated by drawings and photographs. (Catalog 61)

(18) Charging Machine

Salem-Brosius, Inc. has published an illustrated brochure covering auto-floor furnace charging machines, designed in eight models for handling raw materials and shapes that weigh up to 20,000 lb total maximum. The booklet discusses the economy, flexibility and efficiency of this unique method of furnace charging and drawing.

(19) Mold Release Agents

An eight-page booklet has been made available by Linde Air Products Co., describing three new silicones specially designed as shell mold release agents. The bulletin discusses uses and availability of the silicones; stable emulsion stock, ready-to-use solution, and a modified silicone for users who prefer making their own parting solution.

(20) Chemical Cleaning

Dowell, Inc. has made available new literature on the removal of scale from water and gas lines, and the chemical cleaning of condensers. The bulletin on scale removal lists case histories and describes advantages of using chemical solvents to do the job. The publication on condenser cleaning describes the process of using chemicals and the advantages involved.

(21) Carbide Tools

A new catalog has been published by Kennametal, Inc., giving complete specifications and prices for their line of carbide tools. The booklet features the expanded line of profiling tools. A technical data section describes physical and mechanical properties, grade classification and selection, operation suggestions, and wear-analysis for the various Kennametal grades, together with suggested applications. All cataloged products are illustrated by line-drawings on the

inside front cover, with page numbers for easy reference.

(22) Drives for Processing Lines

A recently-published booklet covering drives for processing lines has been published by Westinghouse Electric Corp. Included are sections on pickling, electrolytic cleaning, continuous annealing, coil preparation, electrolytic tinning, continuous galvanizing, shearing and slitting lines. A section is devoted to answering questions on processing line drives. Also included is a partial list of Westinghouse installations. A wealth of diagrams and pictures make this publication worthwhile reading for the operating man.

(23) Abrasive Snagging Wheels

Simonds Abrasive Co. has published a bulletin on abrasive snagging wheels. Aimed specifically at steel mill and foundry applications, the brochure discusses billet grinding, as well as the grinding of steel castings, annealed malleables, gray iron, unannealed malleables and nonferrous castings. Also included, are recommended specifications for each application. (Form ESA-62)

(24) Electronic Balancing Machines

A new principle for automatically measuring the amount and indicating the angular location of unbalance by means of electronics, is comprehensively described in a bulletin just released by Tinius Olsen Testing Machine Co. In addition, the bulletin describes features of the complete line of dynamic and static balancing machines including the horizontal and vertical models as well as the automatic crankshaft balancer. (Bulletin 49)

(25) Test Instrument

The versatile line of portable high current test instruments offered by the Multi-Amp Corp. are described in a catalog recently published. Illustrations, dimensions and a general description of these calibrating and testing instruments are included with a listing of indicated uses and industrial applications. Electrical specifications for high current test units are also contained. (Catalog MA-154)

(26) Dust Collector

A bulletin describing their cloth bag dust collector has been published by Pangborn Corp. The pamphlet describes how dust control for all types of finely divided dry dusts can be provided for smaller volume applications at low equipment and installation costs. It points out how the collector was designed for indoor use, permitting clean air to be discharged inside the plant; a practice which results in a distinct savings where air is heated or cooled. Detailed descriptions of the dust collector operation and the cloth bag sealing mechanisms are presented. Also included, are the construction and assembly features of each dust collector. Photographs show front views of the 400 and 800 size collectors and a closeup of cloth bags supported on shaker channels. Line drawings give the side and front elevations of the various size collectors. Pertinent data, such as weight, number of hoppers, cloth area, dimensions and diameter of inlets and outlets for each collector are given in chart form for the reader's convenience. (Bulletin 916)

(27) Flame Cutting for Weldments

Now being offered by Air Reduction Sales Co. is a booklet which relates how a company converted from castings and riveted structures to weldments and discusses the problems involved in making this change. The booklet traces the development and utilization of chain type flame cutting in the fabrication of these units for power shovels. It tells how, using the electronic tracer, to improve flame-cutting flexibility and increase production capacity while reducing the cost of flame-cut parts and steel plate items for these weldments.

(28) Conductivity Tester

Recently published by Associated Research, Inc., is a bulletin describing a newly-designed instrument for measuring conductivity of personnel and equipment in accordance with National Fire Protection Association recommendations. Believed to be the only instrument now available which is capable of making tests in accordance with N.F.P.A. recommendations, this model is suitable for use to measure conductivity of floors, personnel and equipment in ordnance plants, chemical plants, paint factories, refineries, and any other locations where static electricity may be a hazard. (Bulletin 2B)

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IRON & STEEL ENGINEER

1011 EMPIRE BUILDING

PITTSBURGH 22, PA.

PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ALLIS-CHALMERS MANUFACTURING CO.	BULLETINS 14B6410B AND 14B7303	Complete information on Type H starters.
51	AMERICAN AIR FILTER CO.	BULLETIN 241	Complete product data.
52	AMERICAN BRAKE SHOE CO. ELECTRO-ALLOYS DIVISION	BULLETIN T-239	New Thermalloy retorts and muffles bulletin.
53	AMERICAN WHEELABRATOR & EQUIPMENT CORP.	BULLETIN 884	Gives details on Wheelabrator mechanical cleaning.
54	BEDFORD FOUNDRY & MACHINE CO., INC.		Complete catalog describing Bedford Cranes.
55	E. W. BLISS CO.	BULLETIN 40-A	Revised 60 page rolling mill brochure.
56	BRISTOL CO.	BOOKLET P1245	Complete story on electronic potentiometers and pyrometers.
57	BROOKS OIL CO.	PAMPHLET 61	Contains information on Barcote corrosion protection.
58	THE CARBORUNDUM CO.		Booklet describing steel deoxidizing.
59	CLEVELAND WORM AND GEAR CO.	BULLETIN 140	Contains information on feeder table drive.
60	CRANE CO.	FOLDER AD-1881	Full details on small steel gates.
61	M. E. CUNNINGHAM CO.	CATALOG 100	Contains complete data on steel tagging outfit.
62	DE LAVAL SEPARATOR CO.	BULLETIN 500	Contains information on mill lubrication systems.
63	DIAMOND POWER SPECIALTY CORP.	BULLETIN 1136-E	Describes use of wired television for centralized control.
64	DRAVO CORP.	BULLETIN SC 1301	Contains information on industrial air conditioning.
65	ELECTRIC CONTROLLER & MANUFACTURING CO.	BULLETIN 942	Gives information on welded plate resistors.
66	ENTERPRISE CO.	BULLETIN 502	Literature on mill-type friction saws.
67	FARREL-BIRMINGHAM CO., INC.		Descriptive bulletin on roll grinders.
68	D. B. FLOWER MANUFACTURING CO.	CATALOG 41	Facts on brush holders.
69	FOXBORO CO.	DATA SHEET 330-12	Information on open hearth reversal control.
70	GENERAL MOTORS CORP. HYATT BEARINGS DIVISION	CATALOG 150	Latest catalog on roller bearings.
71	HARNISCHFEGER CORP.	BULLETIN C-42	Information on mill type cranes.
72	INDUSTRIAL GEAR MANUFACTURING CO.	BULLETIN 152-A	Pictorial visit to gear and sprocket cutting plant.
73	JOHNS-MANVILLE CORP.	BROCHURE IN-134A	Information on high temperature block insulation.
74	KOPPERS CO., INC., FAST'S COUPLING DEPT.		Catalog giving information on couplings.
75	LEEDS & NORTHRUP CO.	PROCESS DATA SHEET 643(1)	Contains facts on immersion thermocouples.
76	LINK-BELT CO.	BOOK 2416	48-page booklet describing belt conveyor idlers.
77	LINK-BELT CO.		Catalogs on enclosed gear drives.
78	MACKINTOSH-HEMPHILL CO.	PE-54	Details on automatic contour turning lathe.
79	McDANEL REFRACTORY PORCELAIN CO.		Bulletin on industrial porcelains.
80	MINNEAPOLIS-HONEYWELL REGULATOR CO.	CATALOG 9301	Lists instruments for industrial measurement and control.
81	NORTHERN ENGINEERING WORKS.	BULLETIN SE-108-160	Bulletin on new super-cranes.
82	OKONITE CO.	IS-9000	Contains information on Okolite-Okoprene cables.
83	ORANGE ROLLER BEARING CO., INC.		Engineering data book on roller bearings.
84	PLASTEEL PRODUCTS CORP.		Engineers' handbook for use of Plasteel products.
85	PITTSBURGH LECTROMELT FURNACE CORP.	BULLETIN 9	Description of Lectromelt furnace operation.
86	POST-GLOVER ELECTRIC CO.	BULLETIN 500	Details on steel grid resistors.
87	PYLE-NATIONAL CO.	CATALOG 1100	Listing of circuit-breaking plugs and receptacles.
88	RADIO CORP. OF AMERICA		Booklet describing RCA industrial TV.
89	RELIANCE ELECTRIC & ENGINEERING CO.	BULLETIN C-2201	Information on dual-cooled motors and V-S drive.
90	ROME CABLE CORP.		65 illustrated pages describing power and control cables and insulations.
91	RUST-OLEUM CORP.		Literature and color chart on Rust-Oleum.
92	SIMONDS ABRASIVE CO.	BULLETIN ESA-62	Describes wheels for high speed snagging operations.
93	SKF INDUSTRIES, INC.	BULLETIN 365	Gives complete details on type "C" spherical roller bearing.
94	SPRAYING SYSTEMS CO.	DATA SHEET 3997	Contains information on descaling nozzles.
95	STEARNS MAGNETIC, INC.	BULLETIN 35-B-1	Information on lifting magnet operation.
96	CHAS. TAYLOR SONS CO.	BULLETIN 507	Sample and information on high temperature silica cement.
97	S. G. TAYLOR CHAIN CO.	BOOKLET 12C	Facts and specifications on alloy steel chain.
98	UNITED STATES GRAPHITE CO.		Catalog on brushes for electrical equipment.
99	WAGNER ELECTRIC CORP.	BULLETIN MU-185	Complete information on industrial motors.
100	LEE WILSON ENGINEERING CO., INC.		Brochure and date sheets on new type radiant tube.
101	YODER CO.		Book discussing functions and advantages of cold roll forming.

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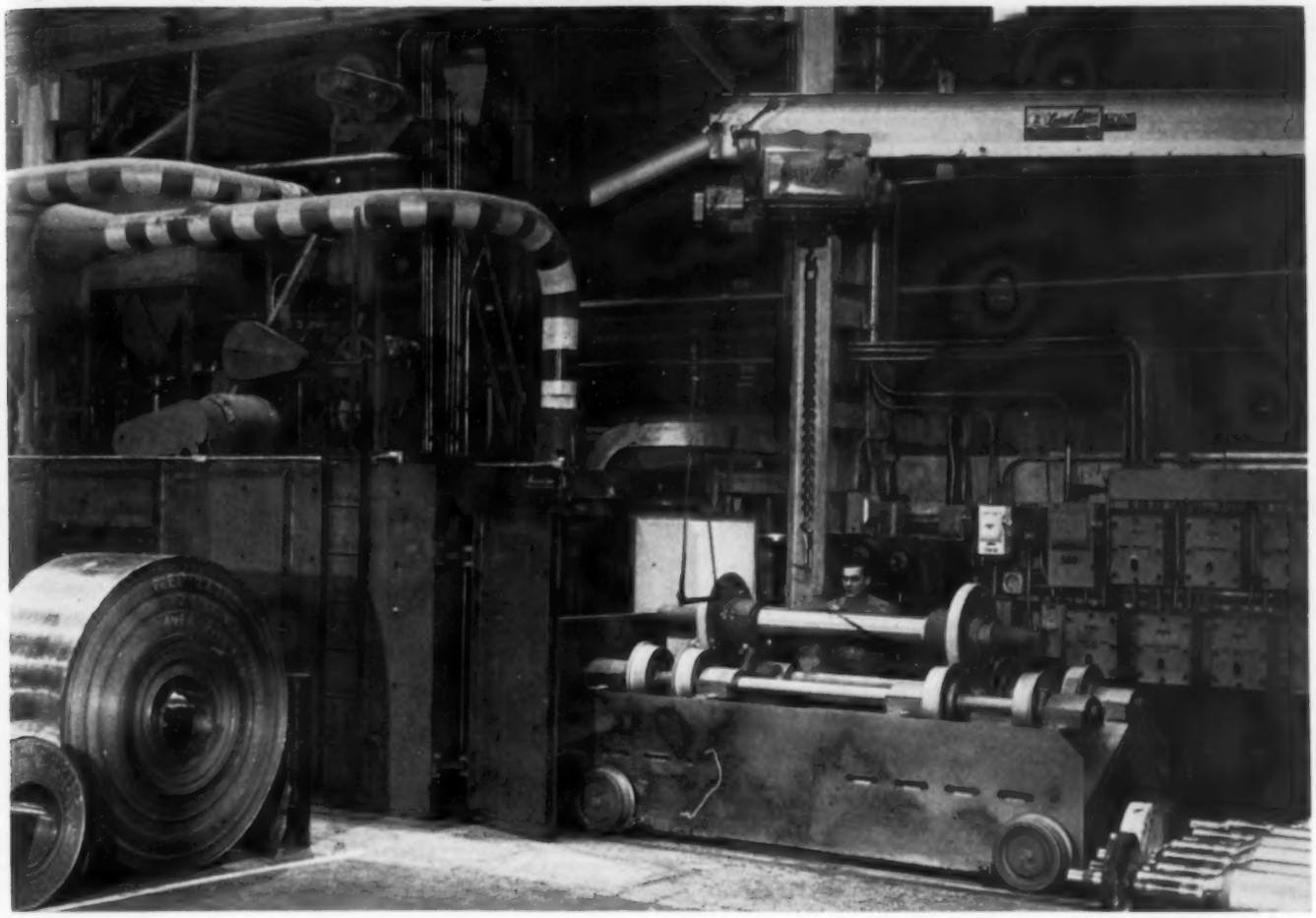
pioneering developments keep **WHEELABRATOR**® *first in blast cleaning*



etching mill rolls in 3 minutes' blast time

Wheelabrator Airless Blasting opens new cost-savings possibilities

Large 26 and 27 inch diameter rolls, used in the cold mill, are etched in just 3 to 4 minutes' blast time at Weirton Steel Company. Temper mill rolls 8 to 9 inches in diameter are etched in 54 seconds' blast time. Using an Airless Wheelabrator etching machine, one operator can perform the complete cycle of loading, blasting and unloading in as little as 3 minutes' time.

PAYS FOR ITSELF — As a result of the more uniform etch obtained in just a few minutes' time, Wheelabrating opens new horizons in cost-saving possibilities. Weirton, for example, was able to amortize its entire investment quickly through savings in the cost of emery paper alone. Another major steel mill realized a 35% increase in the mill service of its Wheelabrator etched rolls.

AN IMPROVEMENT OVER AIRBLASTING — Wheelabrating produces a specified etch uniformly and automatically while airblasting requires several passes of the blast over the roll face under the observation of a skilled operator. Rolls etched with a Wheelabrator have a materially increased life in the mill with a resulting increase in tons rolled per set of rolls.

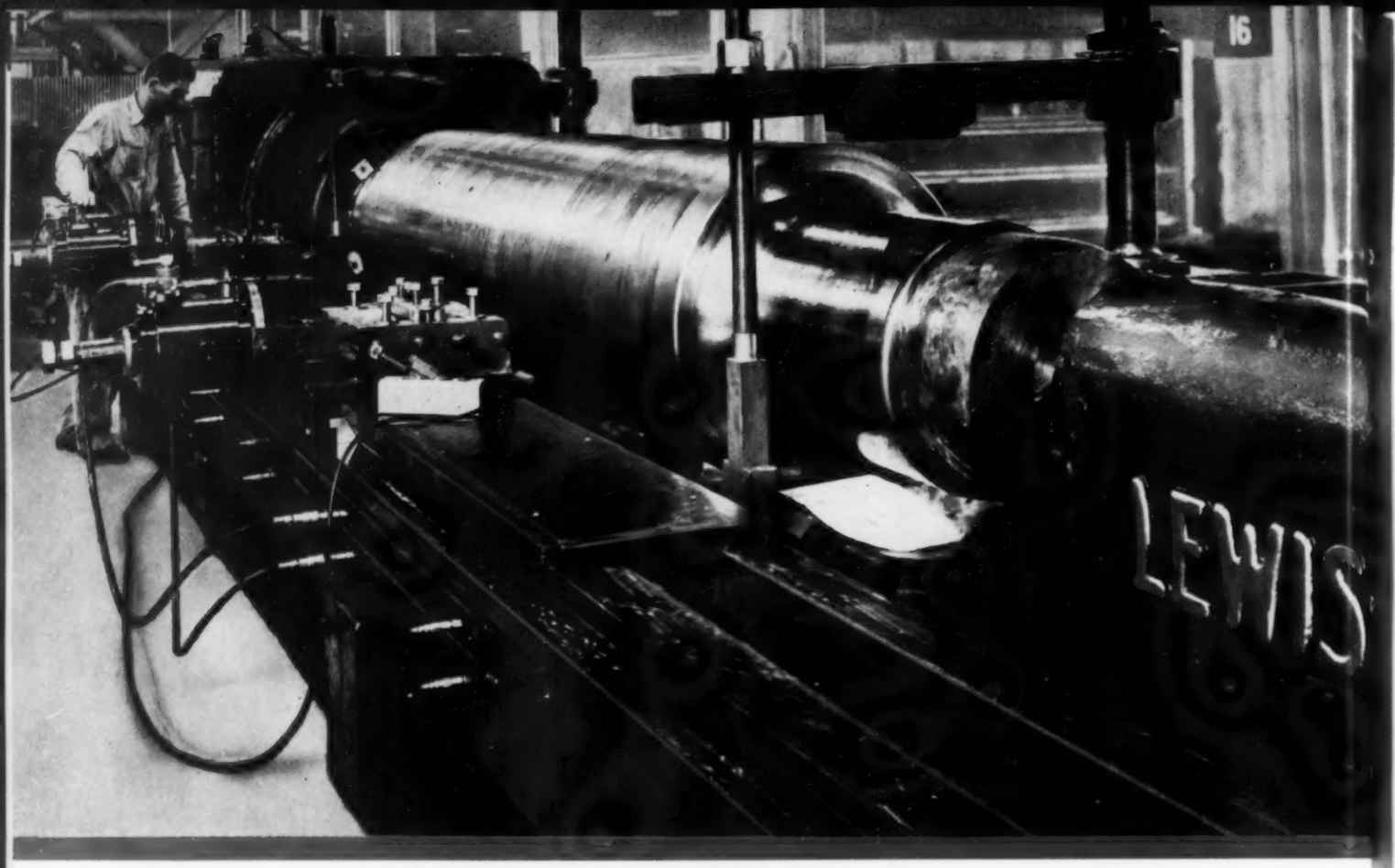
You, too, can save with the Wheelabrator. Write today for full details and a copy of Bulletin 884.

Wheelabrator Mechanical Cleaning is effecting unusual economies in the descaling and surface finishing of strip, sheet, bar stock, etc. Write for full details.

American
WHEELABRATOR & EQUIPMENT CORP.
396 S. Byrkit St., Mishawaka, Ind.

Wheelabrator®
AIRLESS BLAST CLEANING

WORLD'S LARGEST BUILDERS OF AIRLESS BLAST EQUIPMENT



. . . reduces machining costs as much as 75 per cent

When you have to remove considerable metal, this new Lewis Hydraulic Roll Lathe reduces roll turning costs as much as 75 per cent.

By means of three hydraulically controlled movements, the roll machining operation is converted from a recurrent manual task to a practically continuous manual operation.

One—hydraulic control makes it possible in machining to use two tools, eight inches wide, with cuts up to ⅜ inch in depth, across the full face of the roll. And provides a constant, even pressure of the cutting tool against the roll, which increases tool life.

Two—lateral movement of the cutting tool enables the operator to make one continuous spiral cut that travels along the entire length of an even-faced roll . . . thereby eliminating unnecessary set-up time. Two tools can be used, cutting from the same side of the roll and traveling in the same direction. Traverse movement of the cutting tools can be in either direction.

Three—hydraulically controlled movement of the tailstock eliminates what used to be a difficult, time-consuming job that required the efforts of at least two men and sometimes the use of a crane.

At your convenience we will be glad to give you more complete information about the design and performance of this new Lewis Hydraulic Roll Lathe . . . which can be built in any size to customer requirements. And to offer you the assistance of our experienced engineers and our manufacturing facilities to help you with any problem which includes rolling mill machinery.

new LEWIS hydraulic ROLL LATHE

BLAW-KNOX

BLAW-KNOX COMPANY • LEWIS MACHINERY DIVISION
PITTSBURGH 22, PENNSYLVANIA

LEWIS PRODUCTS: Two-High Mills • Three-High Mills • Four-High Mills • Bar and Billet Mills • Rod Mills • Coilers • Tables • Shears • Levelers • Pinion Stands • Gear Drives • Roll Lathes • Flaking Mills

Equipment News...

PILOT BURNER

▲ Partlow Corp., New Hartford, N. Y., has developed the 700 Series Saf-T-Flame pilot for the protection of any gas fired appliance against damage from failure of a gas pilot or gas or electric supply.

Specially developed for application to ovens, air heaters, immersion heaters, furnaces, metal pots, and similar industrial gas burning appliances which utilize a constantly burning gas pilot, this device uses the flame conductivity principle to achieve instantaneous cut-off after pilot flame failure, although no vacuum tubes are required.

A specially designed pilot burner is provided which is fitted with built-in flame-sensing electrodes and easily installed as a single unit. Special fittings and adaptors are available which will allow this pilot burner to be installed on most types of gas burning equipment, with little alteration.

The pilot burner is electrically ignited by a push button on the front of the control case or, in the automatic models, mechanically after a preset purge time delay. Double units are available for multiple burner applications consisting of burners in pairs.

The Saf-T-Flame operates on the flame conductivity principle, using the ability of a gas flame to conduct an electrical current better than air. By placement of suitable electrodes in the pilot gas flame, a small electric current flows across the pilot flame and ceases when the flame is extinguished. This current operates a relay which controls electrically operated valves in the fuel line. Thus, when the pilot is extinguished, the entire fuel supply is instantly cut off. Since it does not depend upon the heat generated by the pilot for its operation, there is no delay in function —the action is instantaneous.

GAS-TESTING UNIT

▲ A new portable, visual unit, for testing gases, has been introduced by Electric Furnace Co., Salem, Ohio.

With this unit the operator can determine, quickly and easily, the quality of gas being produced by a special atmosphere generator, as well as the quality of the atmosphere in special atmosphere heat processing furnaces.

For example: When carburizing or doing other heat processing of high

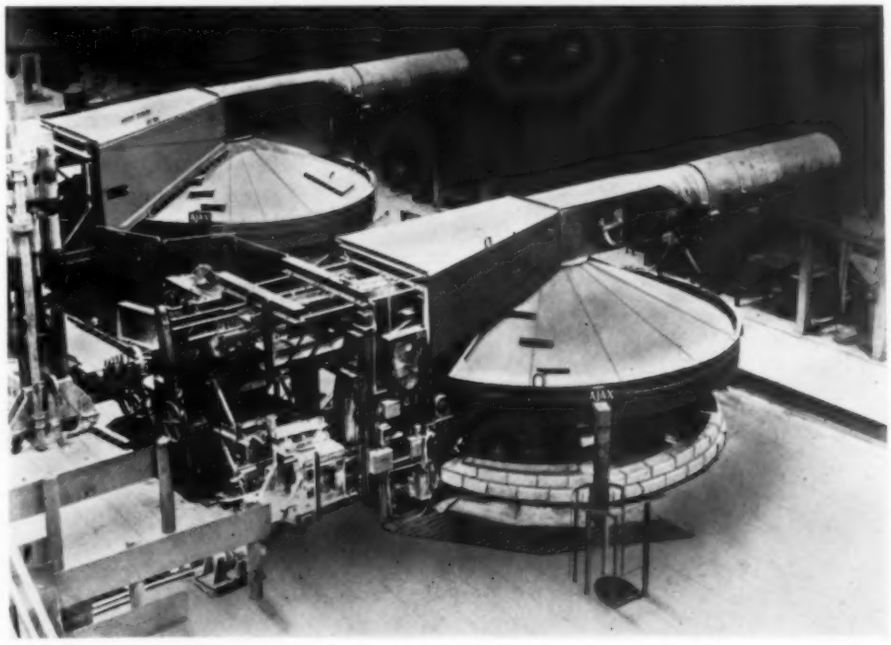
carbon parts, the unit will determine the carbon potential of the atmosphere produced by the generator or present in the furnace.

The visual tester is also used to detect the presence of sulphur, usually detrimental to bright annealing treatments, and may come from such sources as the fuel gas used in producing the atmosphere; the rolling oil used in producing the material being annealed; or even from the furnace lining or from various other sources.

To make a test, the operator simply clamps a strip of metal of similar composition to the material being heat treated, between two electrodes visible within a pyrex tube. Thus the material becomes a resistor in a circuit. The temperature of the specimen is controlled with a rheostat. The gas atmosphere to be tested is then supplied to the tube. The operator raises the temperature of the specimen to the temperature of the material in the furnace, holds the sample at temperature for the desired length of time, then drops the atmosphere to the critical temperature at which the material would discolor in the gas atmosphere being tested. This establishes the length of

SALT BATHS PREPARE BILLETS FOR EXTRUSION

These cannon-like furnaces are electric salt bath units employed to heat stainless steel billets of various analyses to a plastic state prior to hot extrusion. The furnaces are doughnut-shaped with the work transferred through by means of a carrousel-like mechanism. The "barrels" are simply exhaust ducts for venting fumes coming from the molten salt baths. The furnaces are employed to heat 300 and 400 series stainless steel billets, (5¼ in. and 7 in. round, and varying in length from 6 in. to 24 in.) at the Watervilet, N. Y. plant of Allegheny Ludlum Steel Corp. Designed by Ajax Electric Co., the 2300 F molten baths are an integral part of the Ugine-Sejournet hot extrusion process. It takes only 25 minutes to heat a 5¼ in. round from room temperature to 2300 F in these units.



time the material must pass through the critical range in the available atmosphere to prevent discoloration.

The carbon potential of an atmosphere is determined by holding the specimen at temperature in the atmosphere for the desired length of time and then quickly cooling.

The testing equipment is completely housed in a sturdy metal case approximately 22-in. long, 9-in. wide and 9-in. high. Weight of the complete unit is approximately 35 lb.

FORGING STAMPS

▲ Introduction of a new series of flat-faced letter and figure stamps for marking forging dies has been announced by M. E. Cunningham Co. Dies marked with style FR stamps produce finished forgings with raised characters.

Sides of the characters of these stamps are a rounded 45 degree bevel, providing a clearance in the stamped die so that when a part is forged, metal does not lock in the markings. The flat-faced feature assures legibility in the marked forgings, while the round beveled sides reduce the number of rejects due to improper markings.

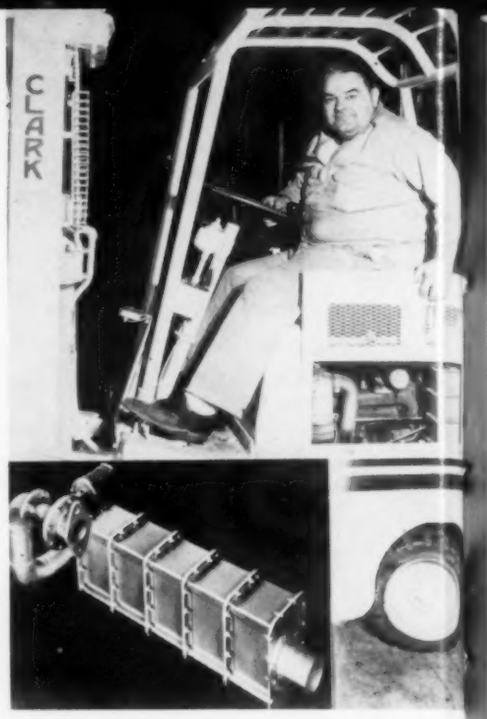
These stamps do not mushroom or spall in service. They are available in a full size range from $\frac{1}{16}$-in. to $\frac{1}{2}$-in. Also, other sizes can be made to order for certain operations—a special production process assures exact duplication of characters on repeat orders.

WELDING ELECTRODE

▲ A new type welding electrode, based on a principle that is different than any other commercially available electrode, has been introduced by Air Reduction Sales Co. This new electrode, known as "Easyarc 12," is for welding mild steel at speeds doubling those obtained with conventional electrodes.

The tremendous increase in speed is achieved by adding a large amount of powdered metal to the electrode coating. The powdered metal changes the arc action so that welds can be made by dragging the electrode in contact with the plate. Because the metal powder becomes part of the weld bead, faster welding is achieved. Weld spatter is decreased to less than half that obtained with regular electrodes.

The weld beads are exceptionally smooth and the weld metal is of high strength, good ductility and excellent x-ray soundness.



EXHAUST PURIFIER

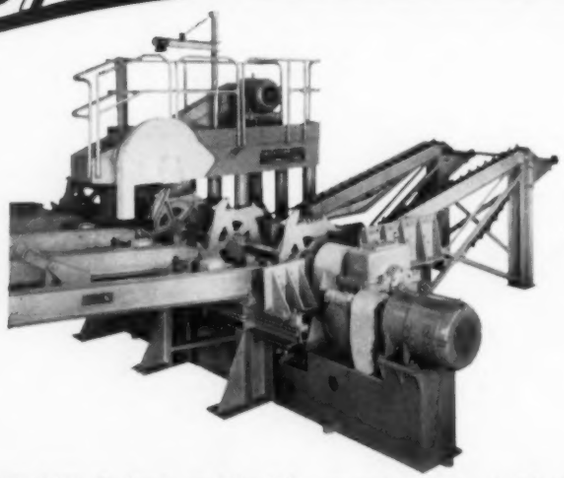
This catalytic exhaust is one of several standard units offered by Clark Equipment Co. for factory installation on fork lift trucks and tractors. A typical installation on a Clark truck is also shown. Manufactured by Oxy-Catalyst, Inc., Wayne, Pa., which makes more than 30 different catalytic exhausts for various makes of fork trucks and for other gasoline-powered equipment, the units oxidize carbon monoxide and hydrocarbons in the engine exhaust, preventing harmful effects from these gases when trucks are operated indoors.

METER SIGNAL UNIT

▲ Hagan Corp., announces that its widely known ring balance meter now is available with a specially designed pneumatic signal transmitter. This makes the instrument readily adaptable to a wide variety of remote metering and control applications, including control installations requiring reset, remote adjustable set point and rates action.

The transmitter is actuated by movement of the pen arm or indicator follower of the meter, without introducing any perceptible load on the sensing element. These movements are transmitted to a baffle which moves about a fixed pivot to throttle air discharge from the con-

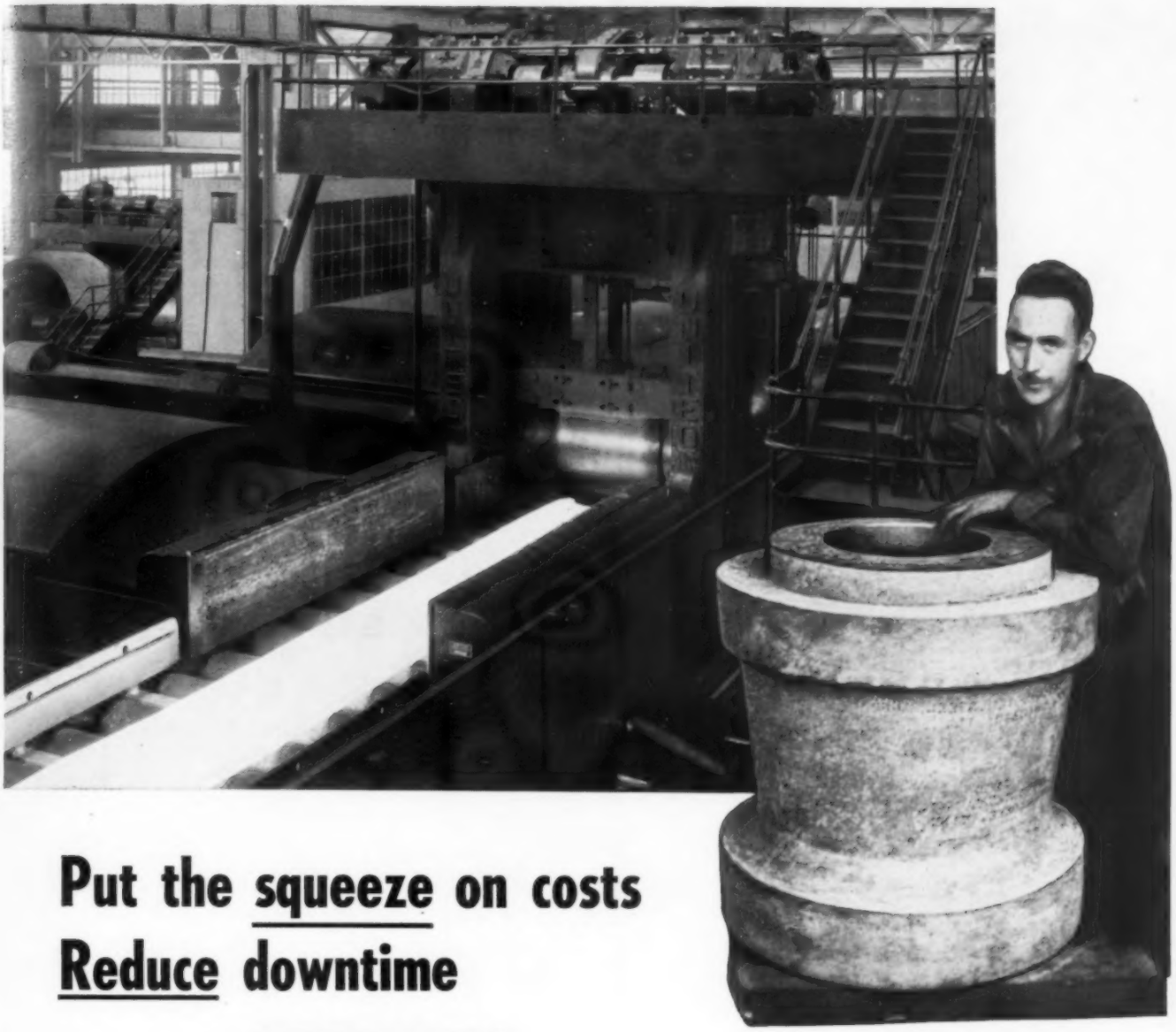
Enterprise
MILL-TYPE
FRICTION SAWS



ENTERPRISE designs and builds several types of friction saws for specific requirements. Shown above is a recently-built Middle Cut Saw with Converging Table for automatic handling ½- to 2-in. OD pipe or conduit. A similar saw handles 2½- to 6-in. pipe. Other varieties are available, such as: Crop-End Saws, Swing Saws, etc. Literature on request. . . .

WRITE FOR BULLETIN 502

ESTABLISHED 1870
THE ENTERPRISE COMPANY
MACHINERY BUILDERS & ENGINEERS
SUBSIDIARY OF WM. K. STAMETS COMPANY—PITTSBURGH
COLUMBIANA 1, OHIO, U. S. A.



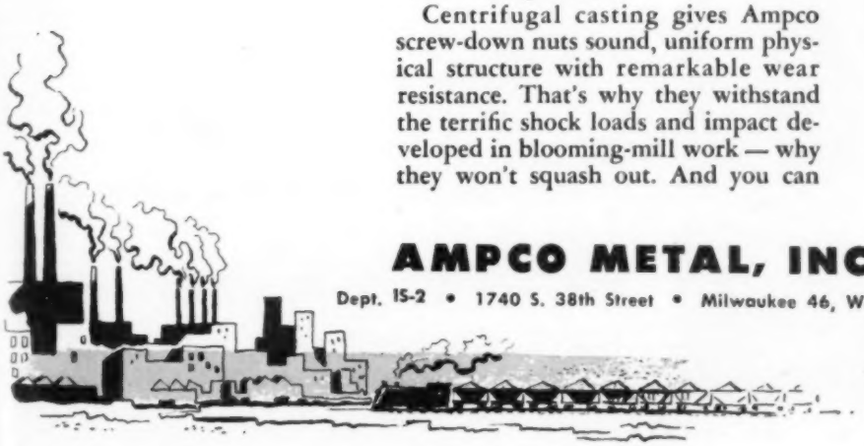
Put the squeeze on costs
Reduce downtime
...use AMPCO*
Screw-down Nuts

CUTTING costs is old stuff to Ampco Metal. And when Ampco is centrifugally cast into screw-down nuts for blooming-mills, you find no equal for top performance — lower costs — longer runs.

Centrifugal casting gives Ampco screw-down nuts sound, uniform physical structure with remarkable wear resistance. That's why they withstand the terrific shock loads and impact developed in blooming-mill work — why they won't squash out. And you can get Ampco screw-down nuts in sizes up to 6000 pounds.

Wherever extra toughness and wear resistance is important, you find Ampco Metal on the job — in slippers, wear plates, flash-welding dies. Its high resistance to corrosion saves money for you in pickling equipment and similar applications.

Your nearby Ampco field engineer is glad to give you full information. Contact him today or write us.



AMPCO METAL, INC.

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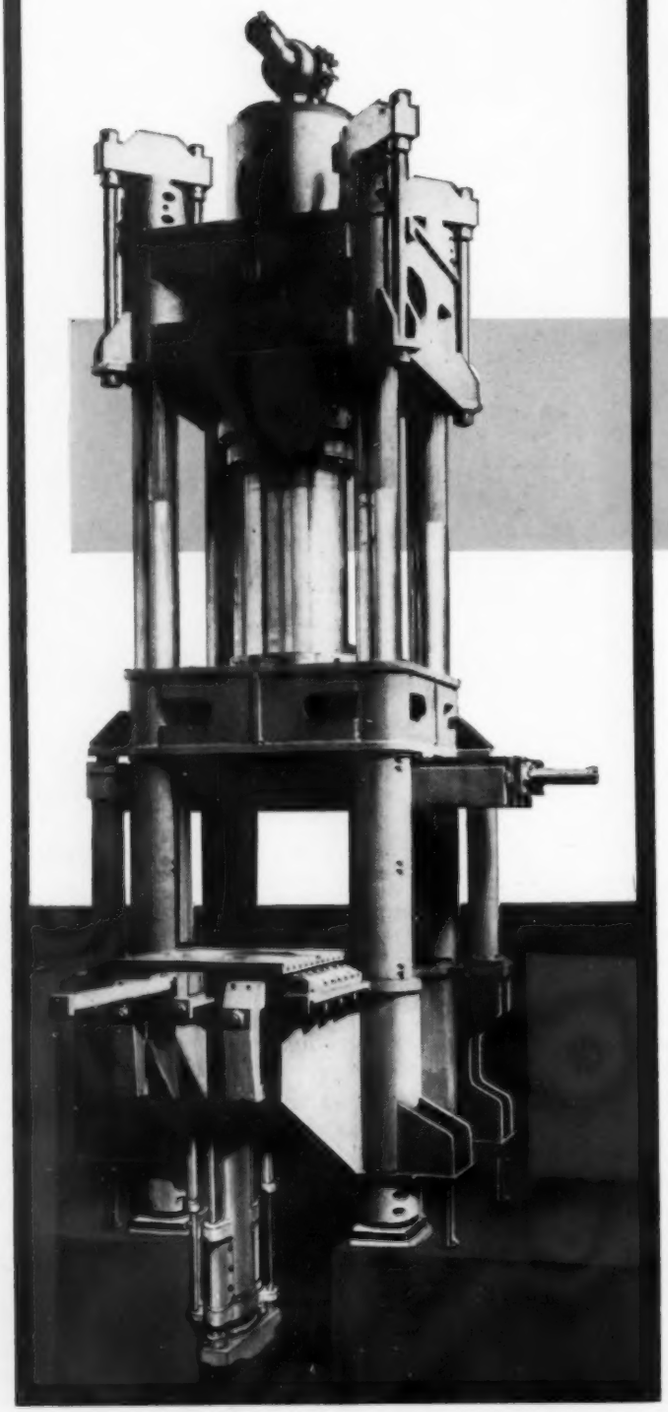
LOEWY—HYDROPRESS

FIRST



IN *HIGH-SPEED* HYDRAULIC FORGING PRESSES

FOR HIGH OUTPUT AND ECONOMICAL OPERATION

2,500 ton fast-working Hydraulic Long-Stroke Punching and Upsetting Press.
Part of a Loewy-Hydropress-built Forge Shop installation of special design.
Installed at the Green River Steel Corporation, Owensboro, Kentucky, the first plant to commercially produce sound ingots made by the Dornin Process.

WE BUILD

- Hydraulic Presses and Power Systems for the Steel and Non-Ferrous Industries.
- Open and Closed Die Forging Plants.
- Deep Drawing Single and Double Acting Presses.
- Extrusion Plants for Steel and Non-Ferrous Metals.
- Hot and Cold Rolling Mills for Steel and Non-Ferrous Metals.
- High-Pressure Pipe Testing and Expanding Machines.

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trol nozzle. Sensing element movement is, therefore, converted into a proportional pneumatic signal that faithfully follows any function measured.

Available maximum signal pressure ranges are 15, 30 and 60 psi. This requires a continuous supply of compressed air. The change from one signal range to another requires only the substitution of the proper calibrating spring. The minimum signal pressure may be substantially zero, or may be suppressed to three or five psi. Output from the transmitter can be used to actuate receiver type indicating, integrating or recording instruments, or as the actuating signal for an automatic control system.

MOISTURE METER

▲ The "Olivo" moisture meter—an accurate, precise, portable instrument for the measuring of surface moisture in powdered, granulated or fibrous material — is now available in the United States exclusively through Heyl & Patterson, Pittsburgh, Pa.

Simple and easy to operate, the meter can determine the surface moisture-content of material in less than two minutes. Using other laboratory methods, the same moisture tests would take as long as four hours.

When properly calibrated, the meter is accurate to two per cent of surface moisture as compared to standard air-dried surface moisture results. For example, a sample having an air-dried surface moisture of 10.0 per cent would have a comparative "Olivo" surface moisture of from 9.8 per cent to 10.2 per cent.

STRAIGHTENING UNIT

▲ The Medart Co. has just released information on a new machine developed especially for straightening thin strips from a few thousandths in thickness up to full capacity of the 20-ton self-contained hydraulic circuit, and as wide as 20-in. Designated as a strip straightener, the model is arranged to take strip from the coil, straighten it, and recoil it.

The machine operates on an entirely new principle, using pass-through stretching heads and an infinitely variable clamping jaw arrangement which provides closely controlled

Kaiser Steel Corporation uses—

TAYLOR MADE

the only complete line of

ALLOY STEEL CHAIN

because...

● Taylor Made Alloy Steel Chain has twice the tensile strength (125,000 lbs. P.S.I.) of wrought iron chain (48,000 lbs. P.S.I.)!

● This famous nationally advertised chain is heat-treated—never requires annealing!

● It has tremendous resistance to shock, grain-growth and work-hardness at all temperatures!

● All slings are furnished with amazing new Taylor Made Alloy Steel Tayco Hooks!

● Rings, joiner links and other sling attachments are of the same analysis, heat-treated alloy steel as the chain.

S. G. TAYLOR CHAIN CO., Hammond, Ind.

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Rush free copy of Booklet No. 12C giving all the facts and specifications on Taylor Made Alloy Steel Chain!

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TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

pressure for clamping the strip. Unique design of the grip jaws reduces jaw marking to an absolute minimum.

Automatic in operation, the operator merely presses the starting button to begin the cycle and the machine stretches, releases, coils and restretches, producing strip in excess of 350 ft per minute. A specially designed integrating unit assures the proper percentage of stretch will be given to each section of the coil. The device goes into action immediately upon taking the slack out of the piece to be stretched, allows only the preset percentage of stretch, and then automatically returns the machine to the starting cycle without operator attention.

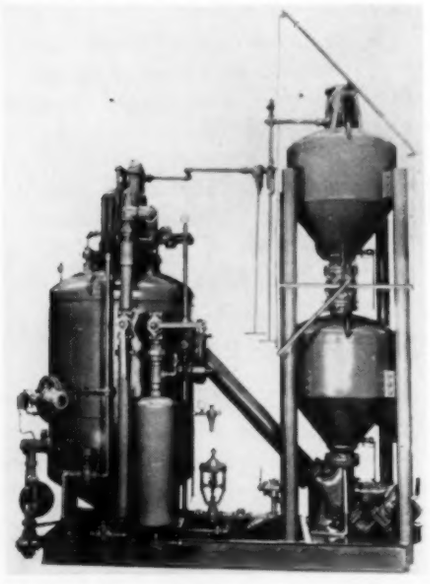
The strip produced from the machine is perfectly straight even when the entire coil is unrolled and tested. The machine will remove camber and can also be used to improve the temper of strip at a high rate by the hydraulic stretch method. It is also very versatile and can stretch up to five narrow strips at one time, and can operate in connection with a slitter, or can be equipped with a special flying shear for shearing the strip to length after it has been straightened.

ACETYLENE GENERATOR

▲ A continuous, dependable supply of medium-pressure acetylene is delivered at a constant output pressure by Oxweld NA-7 acetylene generators. Developed and introduced by Linde Air Products Co. division of Union Carbide and Carbon Corp., it produces high-quality acetylene—at rates up to 9,000 cu ft per hr. It generates just enough gas to meet the immediate demand from consuming equipment, even though this demand fluctuates over a wide range. This is accomplished by two unique features: (1) a double hopper carbide supply, and (2) a variable speed drive for the carbide feed screw.

Two hoppers, one above the other, supply carbide to the feed screw in such a way that operations are never interrupted. The upper hopper serves to replenish the carbide supply in the lower hopper. It can be recharged while the lower hopper continues to supply carbide through the feed screw to the generating chamber.

Any desired output pressure between 8 and 13 lb per sq in. can be preset on a convenient pressure con-



troller. A pneumatic-mechanical linkage between the pressure controller and the variable speed drive of the carbide feed screw automatically regulate the rate of generation by regulating the speed of the feed screw. Thus there is always a continuous supply of acetylene, delivered at a

The combination of heat and wear resulting from high speed travel as steel runs through a mill guide continually works towards its destruction. For this severe application a material is required which combines heat and wear resistance with adequate strength—all are inherent properties of these guides made by Rosedale Foundry and Machine Company.

Metal structure and physical properties are controlled to meet particular mill applications. Uniformity, absence of hard or soft spots, is essential for long service whether the required structure is soft ferrite or high strength pearlite. Free graphite of controlled size and distribution provides thermal shock resistance and lubrication.

Rosedale Foundry has the experience—built on supplying heavy duty castings for the nation's largest steel mills—to meet your requirements for severe applications. Any inquiry regarding possible applications of Meehanite castings will receive prompt attention from our engineering staff.

ROSEDALE FOUNDRY & MACHINE COMPANY
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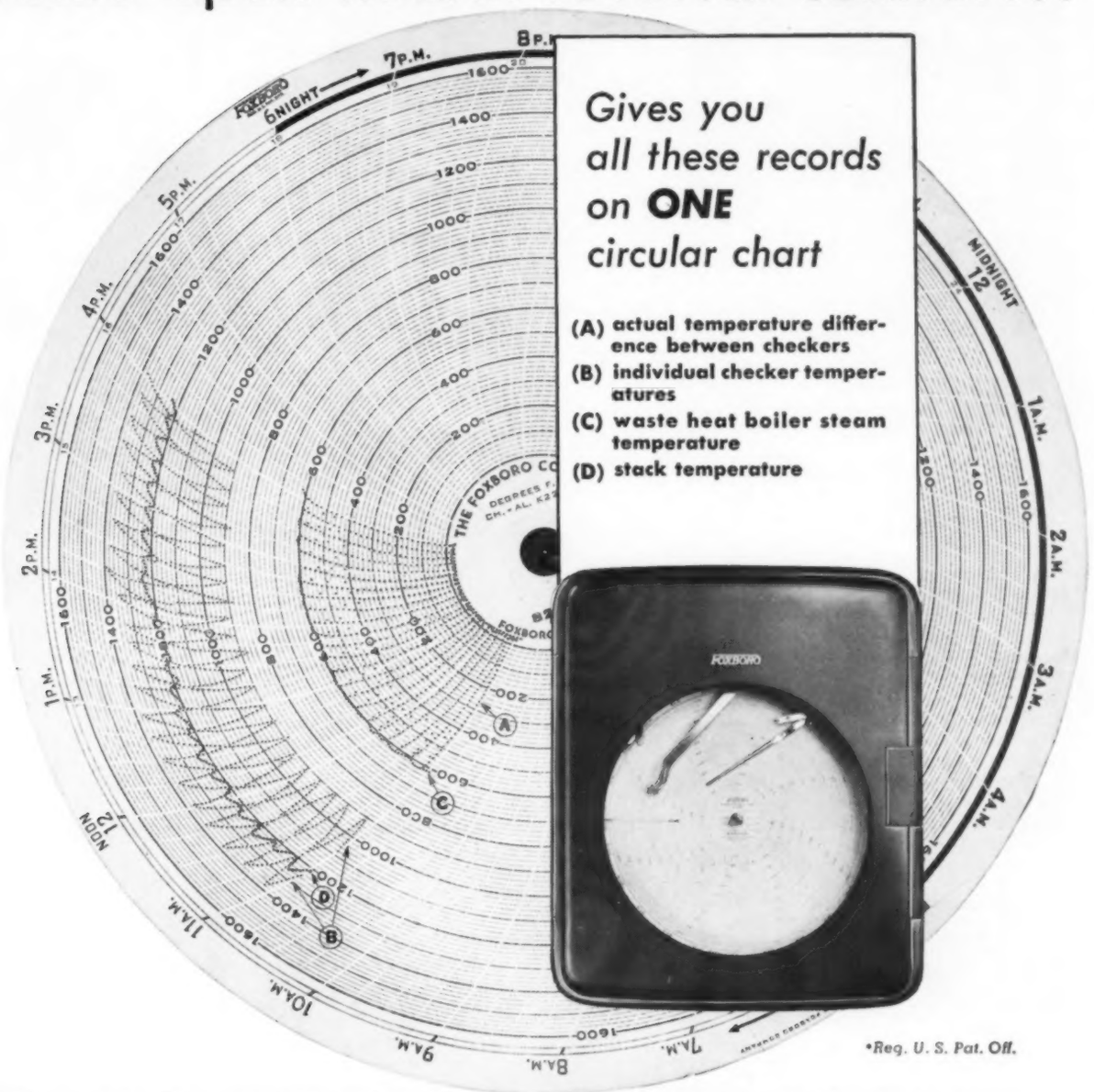
Only DYNALOG* electronic open hearth reversal control...



*Reg. U. S. Pat. Off.

This versatile open hearth reversal controller not only keeps the bath at peak temperature without damage to checker brickwork, but also records key temperatures in the regenerative and waste heat systems at the same time.

Because all these records are accumulated on one circular chart, in distinctive coded colors, open hearth operation becomes easier, more efficient. There's a real saving in panel space, too.

Reversal control is actuated by checker temperature difference, or high checker temperature . . . whichever pre-set limit occurs first. Can be interwired with time reversal systems. Warning alarms and direction-of-firing signals are available options.

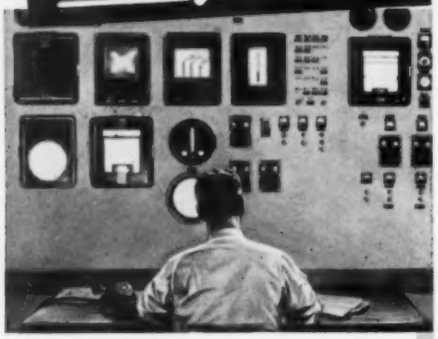
For complete information, write for your copy of Engineering Data Sheet 330-12 or consult your local Foxboro Field Engineer.

THE FOXBORO COMPANY, 582 NEPONSET AVE., FOXBORO, MASS., U.S.A.

FOXBORO REG. U. S. PAT. OFF. DYNALOG TEMPERATURE CONTROL

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

DIAMOND
"UTILISCOPE"
(WIRED TELEVISION)
IMPROVES
Centralized Control



Operator in central control room of large power station "SEES WHERE HE CAN'T LOOK". Here he watches flame conditions in boiler furnace, stack smoke discharge, and water level in boiler on "Utiliscope" screens of control panel.

Centralized control is much more effective if it brings a SENSE OF REALISM into the control room . . . if the operator can actually see what is going on outside his range of vision instead of depending upon indirect interpretations of operating conditions. The electric power industry has accepted the "Utiliscope" as an important factor in achieving better centralized control (as shown above).

The "Utiliscope" has many other uses in industry where its low cost is quickly amortized by improved operation, greater safety or savings in labor. It is surprisingly simple and requires no special skill for installation and operation. Stability and reliability are exceptional. For additional information use coupon below.

"UTILISCOPE" RECEIVER

"UTILISCOPE" CAMERA

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO

Please send me without obligation a copy of new Bulletin No. 1136 showing how the Diamond "Utiliscope" (Wired Television) is being used to cut costs, improve operations and promote safety.

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Since 1903, Diamond has Manufactured Quality Equipment for Industry

constant pressure, to meet exact requirements. Since no surplus gas is generated, all problems of gas storage are eliminated.

ENCLOSED FLOODLIGHT

▲ The Pyle-National Co., Chicago, Ill., announces the addition of a new 20-in. floodlight, designated type 20175, to the company's extensive line of enclosed, weather-tight, dirt-tight floodlights.

The floodlight, which will insure the economy of maximum lamp life, is designed to burn 1000-watt G-40, 1500-watt G-48, and the 1500-watt PS-52 lamps which have special burning positions recommended by the lamp manufacturers. The floodlight will also take the 750 and 1000-watt PS-52 lamps and 700 and 1000-watt Mercury vapor lamps.

The new floodlight is fully enclosed and constructed throughout of rugged, corrosion proof materials. Door and glass joints have a tight, soft packing seal which keeps moisture and dirt from reflector, lamp and inside of lens thereby preserving the initial high beam efficiency indefinitely, with a minimum of maintenance expense.

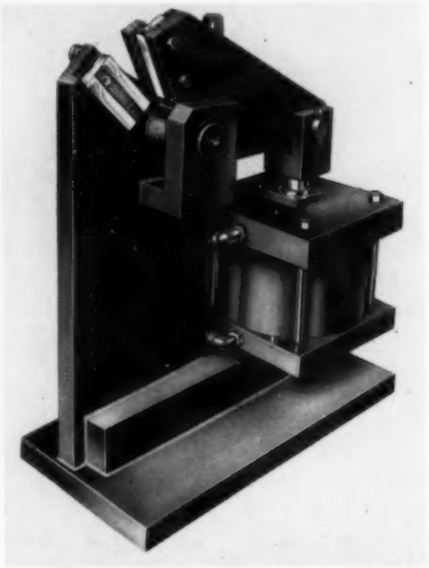
The full 360 degree vertical and horizontal body adjustments are provided with a very sturdy locking device to avoid any chance of accidental movement. A register, which is part of the locking device, makes it very easy to accurately return the projector to its original adjustment, if it is necessary to tilt it or turn it for relamping or cleaning. In addition, angle degree markings are provided to aid in making the original setting meet the specifications of the lighting layout.

AIR-OPERATED SHEAR

▲ Curry Air Shear Corp., Pittsburgh, Pa. has developed a new portable air-operated shear for cropping hot bars (ferrous and non-ferrous) in merchant and bar mill operations. This unit is rated with a capacity to crop up to 1¼-in. diameter hot rounds at any air pressure between 60 and 100 psi.

Completely air-operated, this shear requires a floor space of only 16-in. x 33-in., and weighs less than 1500 lb, a fraction of a motor-operated shear of equal capacity. According to the manufacture, the unit requires practically no maintenance as far as lubrication or replacement of parts is concerned. Design is such that only a single alemite fitting for lubrication and a single set of bearings are included.

The shear features four-edged knives as standard equipment, with



set screws provided for adjustment after grinding. Since the unit operates automatically only at the time of actual cutting, continual running between cuts is eliminated.

DUSTPROOF MOTOR

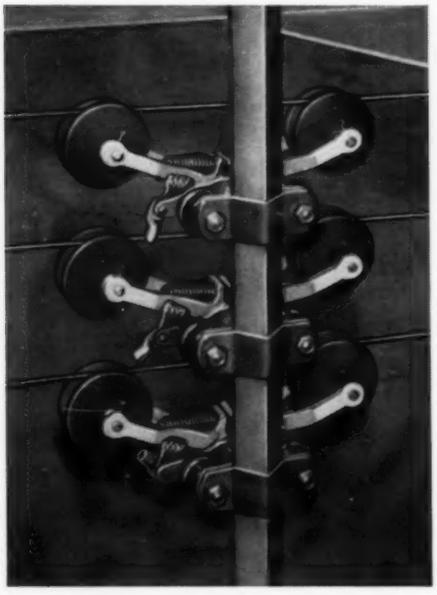
▲ The Crocker-Wheeler division of Elliott Co. has announced a new taconite-dustproof motor. A special modification of its CFC totally-enclosed, fan-cooled motor, it is of particular use in ore refining plants using the taconite beneficiation process where crushing, mixing, and drying operations produce an atmosphere burdened with fine magnetic dust. This dust is extremely injurious to windings, bearings, and other electric motor parts unless these parts are given special protection.

In addition to operation under actual field conditions, the motor has passed exhaustive tests, including running for many hours in a sealed enclosure in which a heavy concentration of taconite dust was constantly circulated—conditions under which any standard motor would have been completely ruined. When disassembled, absolutely no dust was found in bearings or windings. Features which make this possible are nonferrous slingers and bushings, a heavy fibrous grease seal, prelubri-

GRAPHITAR®

current collector wheels for overhead electric cranes

GRAPHITAR current collector wheels increase operating efficiency, reduce maintenance costs and give longer service in this difficult application



Excellent conductors of electricity, GRAPHITAR (carbon-graphite) collector wheels for overhead electric cranes provide numerous advantages over ordinary metal wheels. GRAPHITAR is self-lubricating, making bushings unnecessary and completely eliminating the need for greasing. GRAPHITAR minimizes pitting, arcing and burning, thus putting an end to dead spots in the line that reduce operating efficiency. GRAPHITAR wears exceptionally well and will give longer service than ordinary metal wheels. GRAPHITAR is chemically inert and will not be affected by fumes, heat, cold, rain or snow. For complete information, write us today

OUR 100th YEAR

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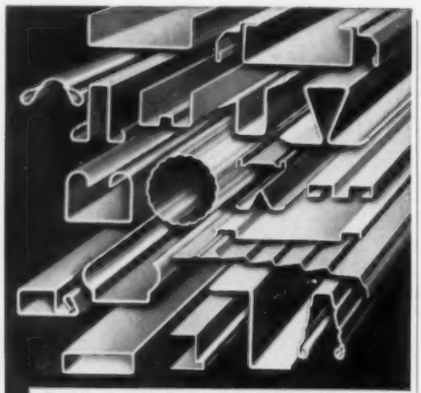
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN



a CHALLENGE and a PROMISE

Cold Roll Forming holds a perpetual challenge to your skill and ingenuity in devising new ways to step up production and reduce cost. Infinite possibilities are suggested by thousands of existing applications in the high-production metal working industries.

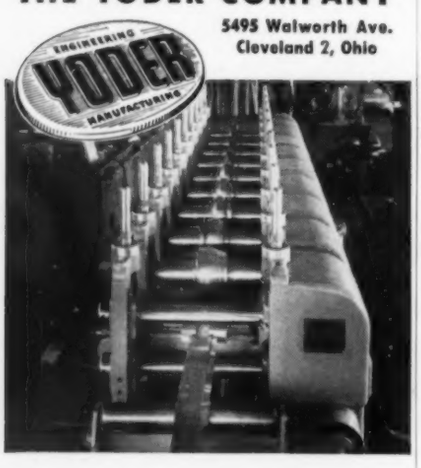
New applications are constantly being discovered. Total production of Yoder cold roll forming machines now runs into billions of feet annually.

A Yoder roll forming machine can be arranged for doing other operations, such as notching, embossing, perforating, curving, coiling, welding, etc., at little or no extra labor cost. Yoder engineers are at your service in designing such multi-purpose production lines.

The Yoder Book on Cold Roll Forming discusses its varied functions and advantages, with scores of photos illustrating end uses of roll formed products. Ask for it.

THE YODER COMPANY

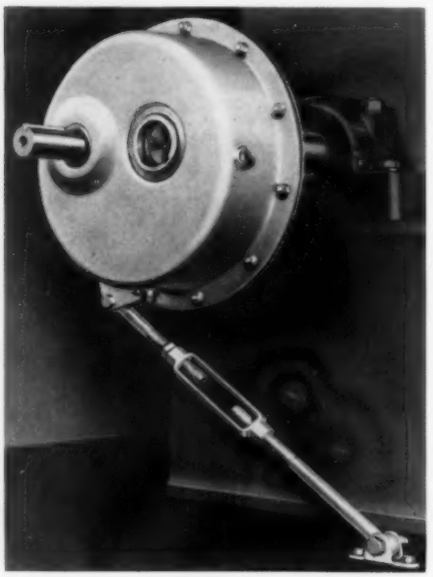
5495 Walworth Ave.
Cleveland 2, Ohio



cated and sealed ball bearings, and a long, close-tolerance fit between bearing brackets and frame. Leads are sealed in with an air-hardening plastic, and the motor is selfcleaning with its fan driven cooling air directed along the heat radiating fins and no outer casing under which dust can collect.

SPEED REDUCER

▲A new speed reducer which mounts directly on the shaft to be driven, and requires no floor space other than that needed for the motor and tie rod connection has been introduced by the Falk Corp. Easily adapted to fit various driven shaft diameters, this drive offers comparatively high ratios



of speed reduction in very limited space.

A choice of single or double reduction unit makes possible the selection of almost any output speed between 420 and 14 rpm, merely by changing sheave sizes within allowable limits. Six sizes to cover the range from ½ to 30 hp. All-steel construction, highly efficient helical gearing, positive lubrication.

REFRACTORY GUN

▲ A new, compact pneumatic refractory gun designed to reduce the cost of many time-consuming hand-applied refractory jobs in small ladles and other confined places has been introduced by the Vibron Division of the Burgess-Sterbentz Corp.

In addition, the bantam gun makes it possible to apply refractories with 40 to 50 per cent less moisture and thus produce longer-lasting refractory linings or patches. Lining shrinkage, drying time is reduced, operating life of equipment is increased.

The powerful, high frequency stroke is achieved by a piston which is caused to reciprocate in a cylindrical passage by introducing compressed air alternately to the opposite ends of the cylinder. Simultaneous with introduction of the compressed air at one end, the spent air at the opposite end of the piston is exhausted. The energy of the reciprocating piston is transmitted to the heads through the compressed air ahead of the piston. This self-contained super-charging design eliminates metal-to-metal impact.

The gun weighs only five lb and is fast and easy to use. It operates at greatest efficiency between 85 to 130 psi. The small head is ideal for initial sewing or ramming while the larger molding head is used to apply a superior finish to the refractory. The gun comes equipped with a 10 ft flexible air hose and quick-connect swivel coupling.

Some of its many uses include the application of new linings or patches in ladles, cupolas, slag troughs, tap ports and holes, electric furnaces, torch pits, heat-treating quench tanks, coupon molds, heat-treating furnaces, kiln, boilers, etc.

THERMOCOUPLE UNIT

▲ A new thermocouple protection tube combining the thermal conductivity and shock resistance of metal with the oxidation and deformation resistance of ceramics has been announced by the Bristol Co., Waterbury, Conn. The new Metal-Ceramic LT-1 thermocouple well has a wall thickness of only ⅛-in., so time lags in temperature response are drastically reduced. The material itself has a thermal conductivity about the same as cast iron.

The tubes have strength at high temperature, are much superior to most ceramics in resistance to thermal shock, and are resistant to air oxidation, combustion gases, and attack by molten steel and slag.

Available in lengths of 12, 18, and 24-in., the metal-ceramic well can also be supplied in a complete thermocouple assembly; straight type, connection head extension type, and connection head angle type are offered.

V. R. BROWNING
MILL TYPE CRANES
TO Specification
Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

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Republic Steel Corporation

"I'm proud to be a Savings Bonds salesman for Uncle Sam and I urge every business executive in the nation to advance the cause of American enterprise in this way.

"Every one of us at Republic Steel is proud of the results of our Payroll Savings campaign: 96.7 per cent of our employees saving systematically from each pay in U. S. Savings Bonds. These results were possible only because all 68,344 of us at Republic were part of an enthusiastic team. We feel that this is the best way we can demonstrate our appreciation of the efforts to have a sound dollar and a stable economy."

- 96.7% of Republic Steel's 68,344 employees—over 66,000 men and women—are enrolled in the Payroll Savings Plan.
- These 66,000 members of Republic's "enthusiastic team," as Mr. White so aptly terms them, are investing more than $16,000,000 per year in U. S. Savings Bonds.
- In addition to building personal security, these men and women of Republic are making a very important contribution to America's "efforts to have a sound dollar and a stable economy."

Certainly Republic Steel's Payroll Savings record is outstanding—one of the best in the country. But it is not unique. Other companies have comparable records, measured in percentage of employee participation, or in annual Savings Bond purchases.

In every company with a high percentage Payroll Savings Plan you will find that the president or top executive appreciates the importance of the Plan and what it means to personal and national security. He knows that 45,000 companies have Payroll Savings Plans . . . that 8,000,000 employees of these companies are investing more than $160,000,000 per month in Savings Bonds . . . that the cash value of Savings Bonds held by individuals today is more than 36 billion dollars—and rapidly mounting, thanks largely to the steadily increasing family of Payroll Savers. He is 100% behind his company's Payroll Savings Plan, and everybody in the company knows it. He takes personal pride in watching employee participation grow to 60%, 70%, 80%, or, perhaps, the high 90's.

If you are not making this important contribution to America's effort for a sound dollar and a stable economy, a wire or letter to Savings Bonds Division, U.S. Treasury Department, Washington, D. C., will bring prompt cooperation from your State Director. He will show you how easy it is to join Mr. White and thousands of other executives as a Savings Bond Salesman for Uncle Sam, with a company Payroll Savings Plan that you can be proud of.

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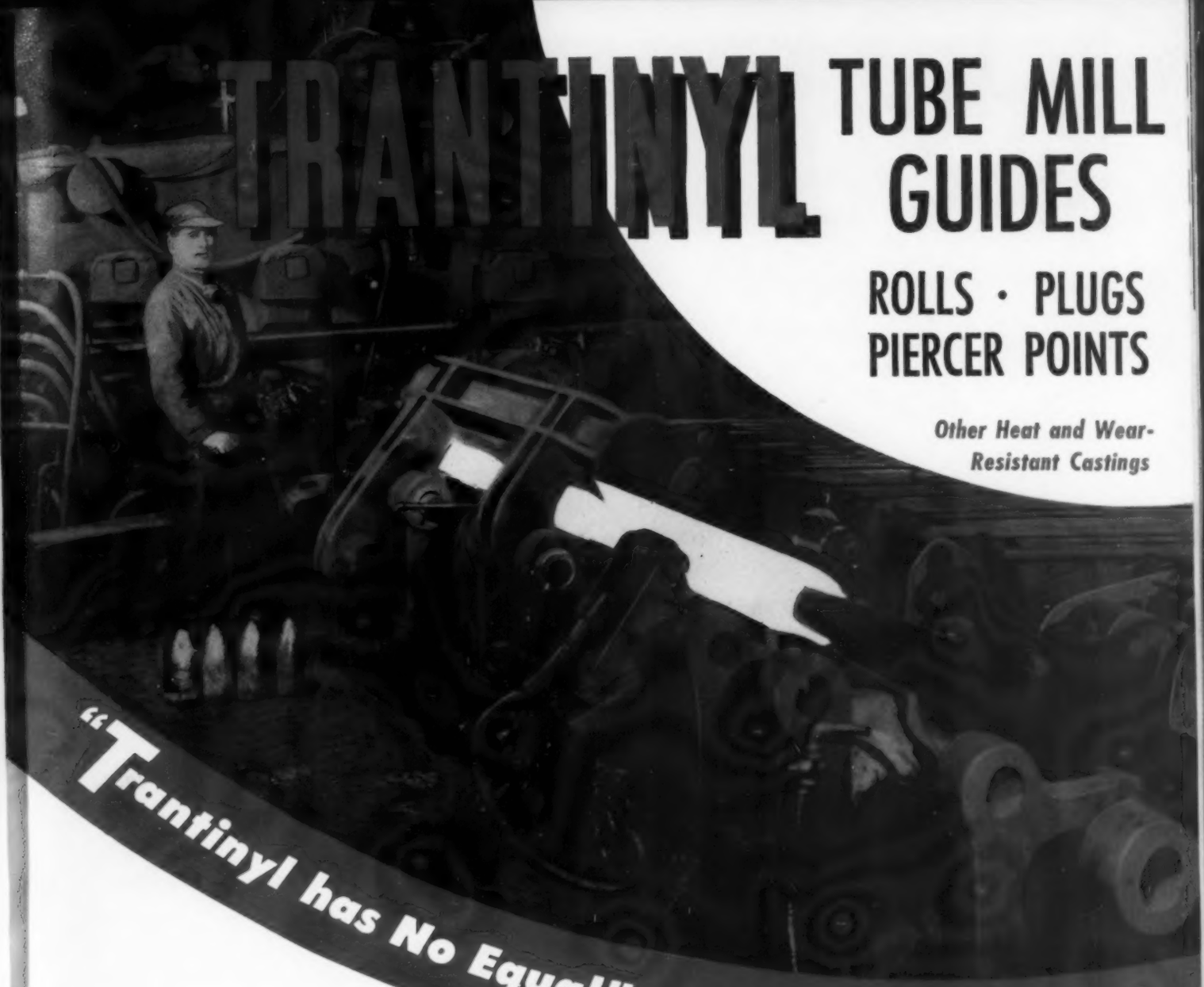
ROLLS · PLUGS PIERCER POINTS

Other Heat and Wear-Resistant Castings



"Trantinyl has No Equal" — say Tube Mill Men!

Reduces Down Time . . . and Aids Profitable Operation

". . . a single set of Trantinyl alloy guides will stand up in our mill during the piercing of as many as 20,000 hot steel billets." • "Instead of being changed frequently, they will remain in the mill in good condition for as long as one to two weeks at a time. We have never been able to find another guide shoe that will equal this . . ." • "We have had as many as 5800 hot billet passes rolled over one single plug . . ." • ". . . Youngstown Alloy Casting Corporation (products) have contributed much toward our success in manufacturing Seamless Tubing of a very high quality."

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SEAMLESS TUBE MILLS:
guide shoes, rolling mill plugs and rolls, piercer points, etc.

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forming rolls, planishing rolls, tool holders, etc.

ROLLING MILLS:
bar, hoop, strip, shape mill guides; and rollers

STRAIGHTENING MACHINE GUIDES · HEAT RESISTING CASTINGS

"TRANTINYL No. 1" CAST TO SHAPE

T3

Youngstown Alloy Casting Corp.

Youngstown, Ohio

Step up your bridge capacity with a new Dravo Man Trolley..

Is your production slowed down because your bridge can't handle the tonnage you need?

Actually, it isn't always necessary to invest in a new bridge to correct this lag. Often an existing structure can be modernized easily by replacing the present man trolley with a light-weight Dravo-built unit.

The operation is practical and requires a minimum of bridge-downtime. One recent installation was completed within eight hours.

Replacement of inefficient, worn or inadequate trolleys can improve your operations at a fraction of new bridge cost. Consultation with a Dravo engineer does not obligate you in any way—and may help you eliminate a production bottleneck. Write or phone . . .

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BRIDGES AND UNLOADERS • TOWER-TYPE UNLOADERS
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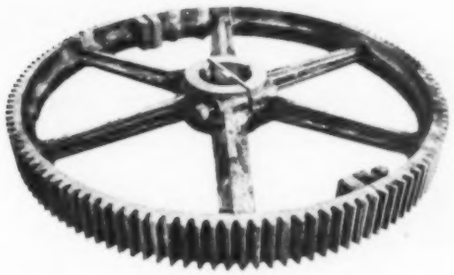
FAST REPAIRS OF HEAVY PARTS with THERMIT

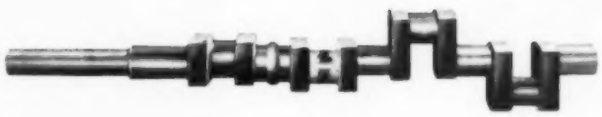
- Cuts downtime
- Eliminates costly replacement
- Repair outlasts original unit

Thermit is used extensively for pinion gear repair.

Heavy machine frame repaired by Thermit Welding.



Crankshaft, 8" in diameter, was restored to duty by Thermit after being broken.



3 fractures in this large ring gear were quickly repaired by Thermit Welding.

When industrial equipment breaks down, the most important problem is to get it back in service—and FAST! Thermit Welding has answered this need time and again . . . in a variety of plants . . . for a variety of parts. Thermit requires a minimum of technical skill . . . gives consistently sound welds . . . is more economical than part replacement. Thermit repairs are permanent repairs.

Investigate THERMIT® WELDING

always ready to work for you

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Book Reviews . . .

▲ **"Mechanical Inspection,"** by W. H. Armstrong was published by McGraw-Hill Book Co., 330 West 42nd Street, New York 36, N. Y., 6¼ x 9¼-in., cloth bound, 362 pp., price $5.50. This book is written in a practical manner to train inexperienced men and women as inspectors in machine shops and other related industries. Book was designed primarily for classwork in technical institutes, vocational industrial schools, and company industrial training programs. It is also sufficiently detailed for self instruction. Major emphasis is on tool description. In addition, there are treatments covering hardness testing, magnaflux, radiographic inspection and statistical quality control. Book is an excellent practical volume.

▲ **"Electric Control Systems,"** third edition, by Richard W. Jones, published by John Wiley and Sons, 440 Fourth Avenue, New York 16, N. Y., 6¼ x 9½-in., 512 pp., cloth bound, $7.75. This book was written primarily as a text for senior students in electrical engineering. It combines the subjects of machinery, electronics, circuits and transients. The book gives a thorough foundation for the study of the more complicated control systems which are becoming a more and more important phase of industrial operations.

▲ **"History of Strength of Materials,"** by Stephen P. Timoshenko was recently published by McGraw-Hill Book Co., 330 West 42nd Street, New York 36, N. Y. 6¼ x 9¼-in., cloth bound, 452 pp., $10. This book was written primarily for students of engineering mechanics with a knowledge of strength of materials and structures. The book presents the history of the development of the science of strength of materials from its beginnings to the present. Material is handled chronologically.

▲ **"Metallurgical Dictionary,"** by J. G. Henderson, recently published by Reinhold Publishing Corp., 330 West 42nd Street, New York 36, N. Y., 6½ x 9¼-in., 396 pp., price $8.50. Semi-encyclopedic in nature, this book has been selectively limited to provide a comprehensive easy-to-use tool for those who manufacture metals and metal products. Book is arranged specifically for the metal industry, and contains over 5000 informative definitions and descriptions covering all the most essential terms in both production and physical metallurgy. Particular care has been taken to cross-reference entries of related terms.

▲ **"Elements of Heat Treatment,"** published by John Wiley and Sons, 440 Fourth Avenue, New York 16, N. Y. offers a simple introduction to the subject, showing how the mechanical properties of metals and alloys may be altered to suit particular situations. Written by the late George M. Enos and William E. Fontaine, the book is for users such as mechanical and design engineers, commercial plant personnel, and others who have no need to go into detailed physical metallurgy. It provides, rather, a practical background

(*Please turn to page 206*)

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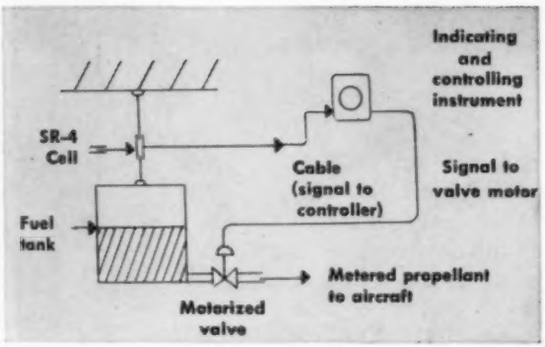

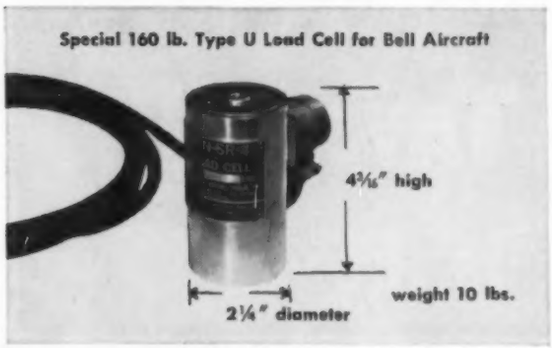

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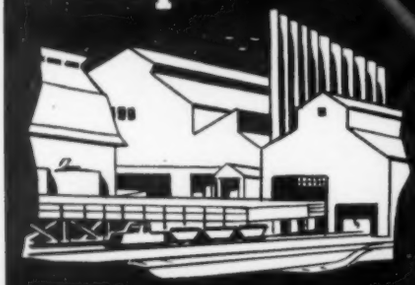

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Book Reviews . . .

(*Continued from page 202*)

in metals and alloys, in which their properties are covered, and an explanation given of how they are tested and evaluated. The discussions of the major processes—annealing, hardening, tempering, and normalizing—are treated from the standpoint of specific jobs that require given characteristics in a metal. "Elements of Heat Treatment" contains 286 pp., 6 x 9-in. and is priced at $5.00.

▲ **"The Heating, Ventilating and Air Conditioning Guide,"** (1953 edition) published annually by The American Society of Heating and Ventilating Engineers, has a total of 1,560 pages and features many important changes and additions. The Technical Data Section has been increased by 32 pages to a total of 1096 pages—the largest to date. The Manufacturers' Catalog Data Section has also been enlarged to 432 pages. Among the new and improved features of this volume are a new section on snow melting, completely rewritten chapters on electric heating and industrial exhaust systems, as well as a new chapter on water vapor and condensation in building construction. New information has also been added on industrial oil and gas burners, short chimneys, industrial degree-days, warm air system design and unit heaters. Copies of the volume, priced at $7.50 each, are available through American Society of Heating and Ventilating Engineers headquarters, 62 Worth Street, New York 13, N. Y.

▲ **"Stress Concentration Design Factors,"** by R. E. Peterson, nationally known authority on the mechanics of materials, has just been published (John Wiley and Sons, 440 Fourth Avenue, New York 16, N. Y.). The book consists of charts and relations useful in making strength calculations for machine parts and structural elements. Price of the book is $8.50, 8 x 10-in., wire binding, 156 pp. Mr. Peterson is Manager of the Mechanics Department, Research Laboratories, Westinghouse Electric Corp., East Pittsburgh, Pa. A working tool for designers, the 150-page book is concerned with the improvement of design calculations that will result in better balanced plans and ultimately reduce operating failure. Amplifying his graphic presentation with succinct explanatory notes, the author covers definition and design relations, grooves and notches, shoulder fillets, holes in plates or shafts and miscellaneous design elements.

▲ **"Weldability of Steels,"** by Robert D. Stout and W. D'Orville Doty, Ph. D. was recently published by Welding Research Council, 29 West Thirty-Ninth Street, New York 18, N. Y. This book consists of 381 pages bound in fabrikoid leather hard covers and copiously illustrated, price $6.50. The early chapters of the monograph cover briefly the fundamentals in relation to weldability. Next comes consideration of the basic factors which influence the weldability of carbon and low-alloy steels, after which are presented suggested methods for welding commonly used steels. The remaining chapters contain a review and critical evaluation of weldability tests and general conclusions on our knowledge of weldability. Probably the most widely useful part of the book is an appendix consisting of 50 pages of tables wherein all of the standard specification steels, such as ASTM, SAE, ABS and others are classified into three catagories, those which are readily weldable, those in which some precautions are needed and finally, those which require special precautions and considerations. Exact welding procedures are indicated for each thickness of steel. These procedures tend to be a bit conservative but are used on the best knowledge available to date.

▲ **"Metal Data,"** second edition by S. L. Hoyt, is similar in form to the popular first edition. In addition to the material included in the earlier work, the most recent information available has been added and much new data on such topics as hardenability of H-steels, new alloys for high temperature stress, etc. Bulk of material is offered in tabular form (about 700 tables and graphs) with a minimum of descriptive text. Book may be obtained from Reinhold Publishing Corp., 330 West 42nd Street, New York 36, N. Y., price $10, 526 pp., cloth bound, 7 x 10-in.

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INDEX TO ADVERTISERS

FEBRUARY, 1954

A

Aetna-Standard Engineering Co. 1, K-33
Air Products, Inc. 132
Ajax Flexible Coupling Co. 129
Alliance Machine Co. 126
Allis-Chalmers Manufacturing Co. 121
American Air Filter Co. 49
American Brake Shoe Co., Electro-Alloys Division 118
American Brake Shoe Co., National Bearings Division 25
American Chemical Paint Co. 154
American Wheelabrator and Equipment Corp. 185
Ampco Metal, Inc. 189
Amsler Morton Corp. K-44
Anker-Holth Division, Wellman Engineering Co. 178
Atlas Car and Manufacturing Co. K-29

B

Baldwin-Lima-Hamilton Corp. 203
Bedford Foundry and Machine Co., The 137
Birdsboro Steel Foundry and Machine Co. 44
Blaw-Knox Co., Machinery Division 186
Blaw-Knox Co., Rolls Division 40, 41
Bliss Co., E. W. 21
Bonnot Co. 155
Bristol Co., The 133
Brooks Oil Co. 147
Browning and Co., Inc., Victor R. 197

C

Carborundum Co., The 177
Chandeysson Electric Co. 152
Cities Service Oil Co. 131
Clark Controller Co. K-30
Clark Equipment Co., Ross Carrier Line, Industrial Truck Division 29
Cleveland Crane and Engineering Co. 46
Cleveland Worm and Gear Co., The K-45, Cover 3
Columbia Electric Manufacturing Co. 142
Commercial Contracting Corp. 130
Continental Foundry and Machine Co. K-39
Crane Co. 139
Crouse-Hinds Co. 170
Cunningham Co., M. E. 146
Cutler-Hammer, Inc. Cover 2

D

De Laval Separator Co. 8
De Laval Steam Turbine Co. 141
Delta-Star Electric Division, H. K. Porter Co., Inc. K-25
Diamond Power Specialty Corp. 194
Documentation and Licenses, Paris, France 50
Dowell, Inc. 134
Dravo Corp. 20, 200
Drever Co. 22

E

Electric Controller and Manufacturing Co. 3, 37, 128
Elliott Co. 4, 5
Enterprise Co., The 188

F

Farrel-Birmingham Co., Inc. 27
Farrell-Cheek Steel Co. 15
Farval Corp., The K-46
Fischbach and Moore, Inc. K-32
Flinn and Dreffein Engineering Co. 50
Flower Manufacturing Co., D. B. 158
Foxboro Co., The 193

G

General Electric Co. 10, 11
General Motors Corp., Hyatt Bearings Division 113

H

Hallden Machine Co., The 50
Harnischfeger Corp. 145
Heppenstall Co. 116
Heyl and Patterson, Inc. 159
Hyde Park Foundry and Machine Co. 157
Hydropress, Inc. 190

I

Industrial Gear Manufacturing Co. 39
Ingersoll-Rand Co. K-26
Insul-Mastic Corp. of America 45
I-T-E Circuit Breaker Co. 34, 35

J

Johns-Manville Corp. 17, 173

K

Kaiser Engineers K-40
Kennametal, Inc. 150
Koppers Co., Inc. 18, 19, 42, 144

L

Lake Erie Engineering Corp. 36
Lassman and Son, Benjamin 13
Leeds and Northrup Co. 31
Link-Belt Co. 7, K-35, 142, 148
Lintern Corp., The 175

M

Mackintosh-Hemphill Co. 160
Mannesmann-Meer Engineering and Construction Co. 119
Manning, Maxwell and Moore, Inc., Shaw-Box Division 38
McDanel Refractory Porcelain Co. 146
McKiernan-Terry Corp. 174
Medart Co., The 151
Mesta Machine Co. K-22, K-23
Metal and Thermit Corp. 201
Miles and Partner, John, London, Ltd. 50
Minneapolis-Honeywell Regulator Co. 32, 33
Morgan Construction Co. 140
Morgan Engineering Co. 169

N

National Carbon Co., Division of Union Carbide and Carbon Corp. 138, 166
National Roll and Foundry Co., The 2
Northern Engineering Works 12

O

Ohio Steel Foundry Cover 1
Okonite Co., The 156
Orange Roller Bearing Co., Inc. K-24

P

Pacific Pumps, Inc. 162
Pennsylvania Transformer Co. 125
Pittsburgh Lectromelt Furnace Corp. 52
Plasteel Products Corp. 127
Poole Foundry and Machine Co. 165
Post-Glover Electric Co. K-41
Pyle-National Co., The 146

R

Radio Corp. of America 48
Refractory and Insulation Corp. 143
Reliance Electric and Engineering Co. 164
Rockbestos Products Corp. 114
Rollway Bearing Co. 43
Rome Cable Corp. K-42, K-43
Rosedale Foundry and Machine Co. 192
Rowan Controller Co. 179
Rust Furnace Co. 109
Rust-Oleum Corp. 6

S

Simonds Abrasive Co. 16
SKF Industries, Inc. 163
Spraying Systems Co. 146
Stamco, Inc. 178
Stearns Magnetic, Inc. 208

T

Taylor Chain Co., S. G. 191
Taylor Sons Co., The Charles 204
Texas Co., The Cover 4
Timken Roller Bearing Co., The K-21
Tool Steel Gear and Pinion Co. K-36, K-37
Treadwell Co., Inc., M. H. K-27
Treadwell Construction Co. K-34
Truflo Fan Co. 153

U

Union Carbide and Carbon Corp., National Carbon Co. 138, 166
United Engineering and Foundry Co. K-28
United States Graphite Co. 122, 195

W

Wagner Electric Corp. 14
Wapakoneta Machine Co. 202
Waterbury Farrel Foundry and Machine Co. 30
Wean Engineering Co. 50
Wean Engineering Co. of Canada, Ltd., The 50
Wean Equipment Corp. 50
Wellman Engineering Co., The K-38
Wilson Engineering Co., Inc., Lee 9
Wing Manufacturing Co., L. J. 161

Y

Yoder Co. 196
Youngstown Alloy Casting Corp. 199
Youngstown Foundry and Machine Co., The K-31

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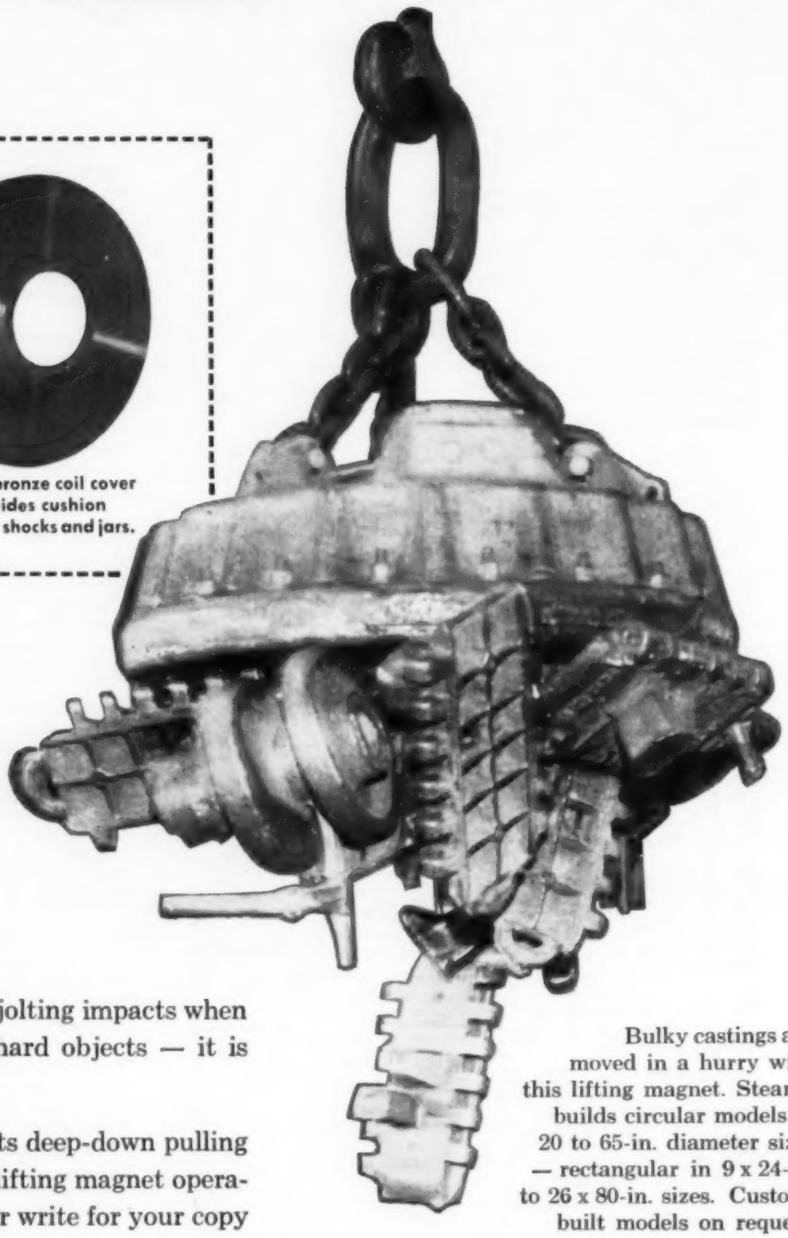

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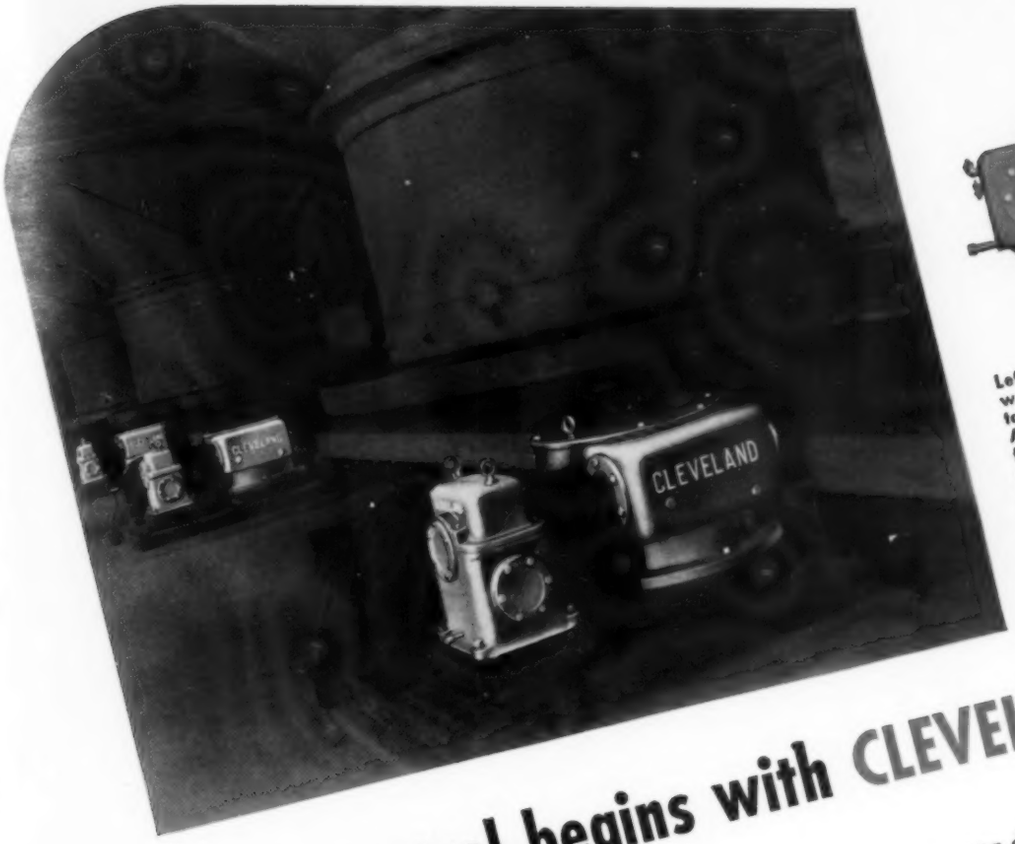

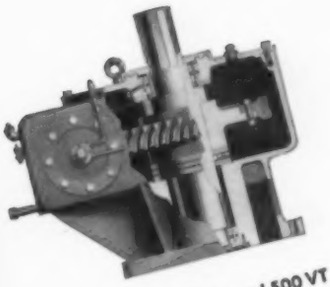

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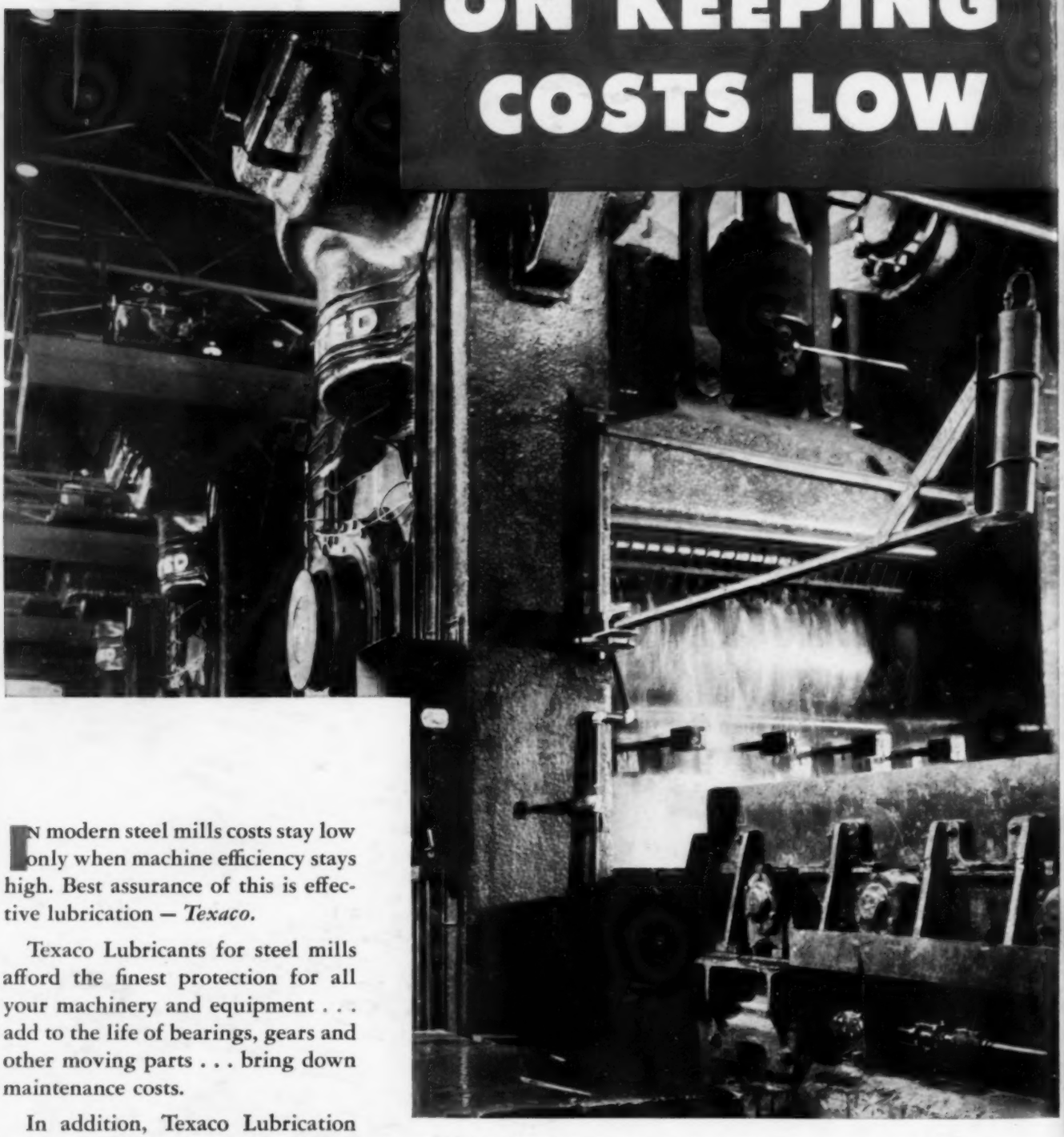

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